

# **PROVIDENCE RIVER & HARBOR RHODE ISLAND SURVEY**

**(REVIEW OF REPORTS)**



**U.S. ARMY ENGINEER DIVISION, NEW ENGLAND  
CORPS OF ENGINEERS WALTHAM, MASS.**

**18 DECEMBER 1962**

## SYLLABUS

The Division Engineer finds that the improvement of Providence River and Harbor desired by local interests is warranted, in that the benefits exceed the costs. He recommends that the existing project be modified to provide a main channel 40 feet deep and generally 600 feet wide into Providence Harbor and a channel 30 feet deep, 150 feet wide along the India Street waterfront, as shown on the maps accompanying the report. The estimated cost to the United States is \$13,900,000, plus a cost of \$58,000 for aids to navigation, \$57,000 for preauthorization studies, and annual maintenance costs of \$24,000 for channel dredging and \$2,900 for aids to navigation. The improvement, which will benefit commercial navigation, has a benefit-cost ratio of 2.1 to 1.

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## Maps Accompanying Report:

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U. S. ARMY ENGINEER DIVISION, NEW ENGLAND  
CORPS OF ENGINEERS  
424 Trapelo Road  
Waltham 54, Mass.

NEDGW

18 December 1962

SUBJECT: Survey (Review of Reports) of Providence River and Harbor,  
Rhode Island

TO: Chief of Engineers  
ATTN: ENCGW-P  
Department of the Army  
Washington 25, D. C.

AUTHORITY

1. This report is submitted in compliance with a resolution adopted 6 January 1950 by the Committee on Public Works of the United States Senate, as follows:

"RESOLVED BY THE COMMITTEE ON PUBLIC WORKS OF THE UNITED STATES SENATE, that the Board of Engineers for Rivers and Harbors, created under Section 3 of the River and Harbor Act, approved June 13, 1902, be, and is hereby, requested to review the report on Providence River and Harbor, Rhode Island, published as House Document Numbered 173, 75th Congress, and other reports, with a view to determining if any modification of the existing project is advisable at this time."

PURPOSE AND EXTENT OF STUDY

2. The purpose of this study is to determine if any modification of the existing Federal project at Providence River and Harbor is advisable at this time. The study considers the possibilities of deepening the existing channel to accommodate deep-draft vessels, of extending the channel to a point just south of Prudence Island Light, and of easing the bends in the existing channel. The study also considers the possibility of deepening the natural channel between Fox Pt. and India Pt.

## DESCRIPTION OF NAVIGATION CONDITIONS

3. Providence River is a tidal estuary extending northerly from the upper limits of Narragansett Bay about 8 miles inland to the City of Providence. The upper 2-1/2 miles comprise the Main Harbor, which is that portion of the river south of Fox Pt. and India Pt. and extending generally south of Field Pt. The Outer Harbor consists of a 35' approach channel, dredged from the Main Harbor southerly to a point just west of North Pt. The approach channel has a minimum width of 600' and is about 8 miles long. The tide ranges are 4.6 feet (mean) and 5.7 feet (spring).

4. The controlling depth in the existing Federal channel is 35 feet except for minor shoaling along the channel limits (1960). There are several sharp bends in the approach channel, the most critical being the bend opposite Pomham Light, the bend at Sabin Pt., and the bend just north of Conimicut Light. In the natural channel between Fox Pt. and India Pt., the present controlling depth is 22 feet.

## TRIBUTARY AREA

5. The tributary area of the Port of Providence covers approximately 2,000 square miles and consists of most of the State of Rhode Island, the northeastern section of the State of Connecticut, and extends into central and southeastern Massachusetts. This area is contiguous with those of the nearby ports of Boston, Fall River, and New Bedford. The exact size of the area differs with the commodity involved and for the petroleum industry it varies with the particular distributing oil company. For this reason the exact population is indeterminate but it seems conservative to state that it is in excess of 1,250,000.

6. Metropolitan Providence is principally industrial with well-diversified manufacturing, textiles, lace goods, jewelry, machinery, fabricated metals, and rubber goods being among the leading products. Most of the high-grade manufactured products shipped out of the area move by rail or truck, the greater preponderance being routed through New York. Providence is served by the main line of the New York, New Haven and Hartford Railroad, which links the port both with the tributary area and also all sections of the country having rail facilities. The port is also served by trucking companies connecting Providence, by major highways, with all sections of New England.

## BRIDGES

7. There are no bridges across the existing Federal project for Providence River and Harbor.

### PRIOR REPORTS

8. Since 1852, when Congress appropriated \$1500 for a survey and \$5,000 for the removal of a rock near the mouth of the Seekonk River in Providence River, there have been 20 prior reports pertaining to navigation improvements in Providence River and Harbor. The most recent are tabulated below:

<u>Published In</u>	<u>Nature and Date of Report</u>	<u>Work Considered and Recommendations</u>
Hse. Doc. No. 1369, 62d Cong. 3rd Sess.	Prelim. Exam. and Survey 1913	30' Channel and harbor proper; Local Coop. to consist of \$2,000,000 <u>expenditure</u> for Terminal improvements. Favorable. Adopted by Riv. & Hbr. Act of Mar. 4, 1913
Hse. Comm. Doc. No. 9, 63d Cong. 2d Sess.	Re-exam of Hse. Doc. No. 1369 63d Cong. 3d Sess. 1914	Local cooperation proviso of Riv. & Hbr. Act of Mar. 4, 1913 amended. Amendment adopted Riv. & Hbr. Act of Mar. 4, 1915
Hse. Doc. No. 173, 75th Cong. 1st Sess.	Prelim. Exam & Survey and Review of Reports 1937	Channel 35' deep, generally 600' wide from deep water in Narragansett Bay to Field Pt. thence widths from 715' to 1700' from Field Pt. to Fox Pt. Favorable - adopted by Riv. & Hbr. Act of Aug. 26, 1937
Not Published	Survey 1940	Channel 25' deep from Fox Pt. to 800' above Point St., then 20' to within 100' of Crawford St. Unfavorable.

## EXISTING CORPS OF ENGINEERS PROJECT

9. The existing Corps of Engineers project provides for an approach channel 35 feet deep at mean low water and generally 600 feet wide through the river from the deep water of Narragansett Bay opposite North Point on Popasquash Neck to the turn below Field Point, 8.1 miles, and thence about 2.6 miles with the same depth and of width ranging up to 1,700 feet to Fox Point, excluding a marginal strip 75 feet wide channelward of the established harbor lines.

10. The existing project was authorized by the River and Harbor Act of August 26, 1937 (H. Doc. 173, 75th Cong., 1st Sess.), and completed in 1949 at a cost of \$2,322,000. Since then \$1,576,000 has been spent for maintenance. In addition, \$3,761,000 was expended for new work and \$650,000 for maintenance for previous projects dating back to 1852.

## LOCAL COOPERATION ON EXISTING AND PRIOR PROJECTS

11. No conditions of local assurance were prescribed in connection with Federal projects for the improvement of Providence River and Harbor prior to 1910. The Federal improvement adopted by the River and Harbor Act of June 25, 1910 stipulated that the Secretary of War receive satisfactory assurances "that the city of Providence, or other local agency, will expend on the improvement of the harbor front, ..... a sum equal to the amount herein appropriated and authorized" (\$434,000). The Federal improvement authorized by the River and Harbor Act of March 4, 1913 provided that no work be done in the harbor project "until the Secretary of War is satisfied that the State and City have completed their proposed expenditures in the combined Providence and Pawtucket Harbors, up to at least \$2,000,000 for public terminals or other permanent public harbor improvements.....". This last provision was modified by the River and Harbor Act of March 4, 1915 to read .... "until the Secretary of War is satisfied that the State and City have completed their proposed expenditures . . . . up to at least \$2,000,000 . . . . or shall have given to the Secretary of War assurance satisfactory to him that the expenditure of \$2,000,000 aforesaid will be completed within a time satisfactory to him and not later than three years from the passage of this amendment."

12. The Federal project adopted on August 26, 1937 was "...subject to the condition that the widening of the channel on the west side immediately below Field Point shall not be undertaken

until local interests furnish assurances satisfactory to the Secretary of War that they will proceed with the downstream extension of the municipal terminal at Field Point."

13. Local interests have complied with all of the above requirements of local cooperation.

#### OTHER IMPROVEMENTS

14. Above the existing Federal project from Fox Point to the head of navigation in the Providence Estuary at Crawford Street, the city maintained a depth of 20 feet prior to 1940. The Fox Point Hurricane Barrier, a Federal project under construction in 1962, will cross this estuary about 1,000 feet above the existing Federal navigation project. The only access by water to the reach of Providence River above the barrier will be that afforded to small boats by the tainter gates. The sill of the gates are at -15 M.S.L. When the gates are open, which is the normal position, they have a vertical clearance of 25 feet above M.S.L. and a horizontal clearance of 40 feet.

15. Adjacent to the northeasterly corner of the existing project, the Federal Government maintains a channel in the Seekonk River, 16-feet deep at mean low water and 150 to 230 feet wide from Red Bridge up to the ledge rock between wharves at Pawtucket, thence 16 feet deep and 100 to 50 feet wide through ledge to Division Street bridge. It is not expected that the considered improvements in Providence River will have any effect on navigation in the Seekonk River.

16. There are two Federal projects on the eastern shore of the Providence River. At Bullocks Point Cove, the project depth varies from 6 to 8 feet and the width is 75 feet. On the Warren River there is a natural channel 9 feet deep up to Warren, Rhode Island.

#### TERMINAL AND TRANSFER FACILITIES

17. There are 28 piers and wharves in the Port of Providence. Six of these are above the site of the Fox Point Barrier beyond which there will be no commercial navigation and three are on the Seekonk River where the horizontal clearances on the bridges are restrictive. Of the remaining 19, there are 7 used exclusively for handling petroleum products, 3 are for the receipt of coal only, 4 receive both coal and oil, 2 are for handling general cargo, and 1 each is used for handling chemicals and scrap metal. One is

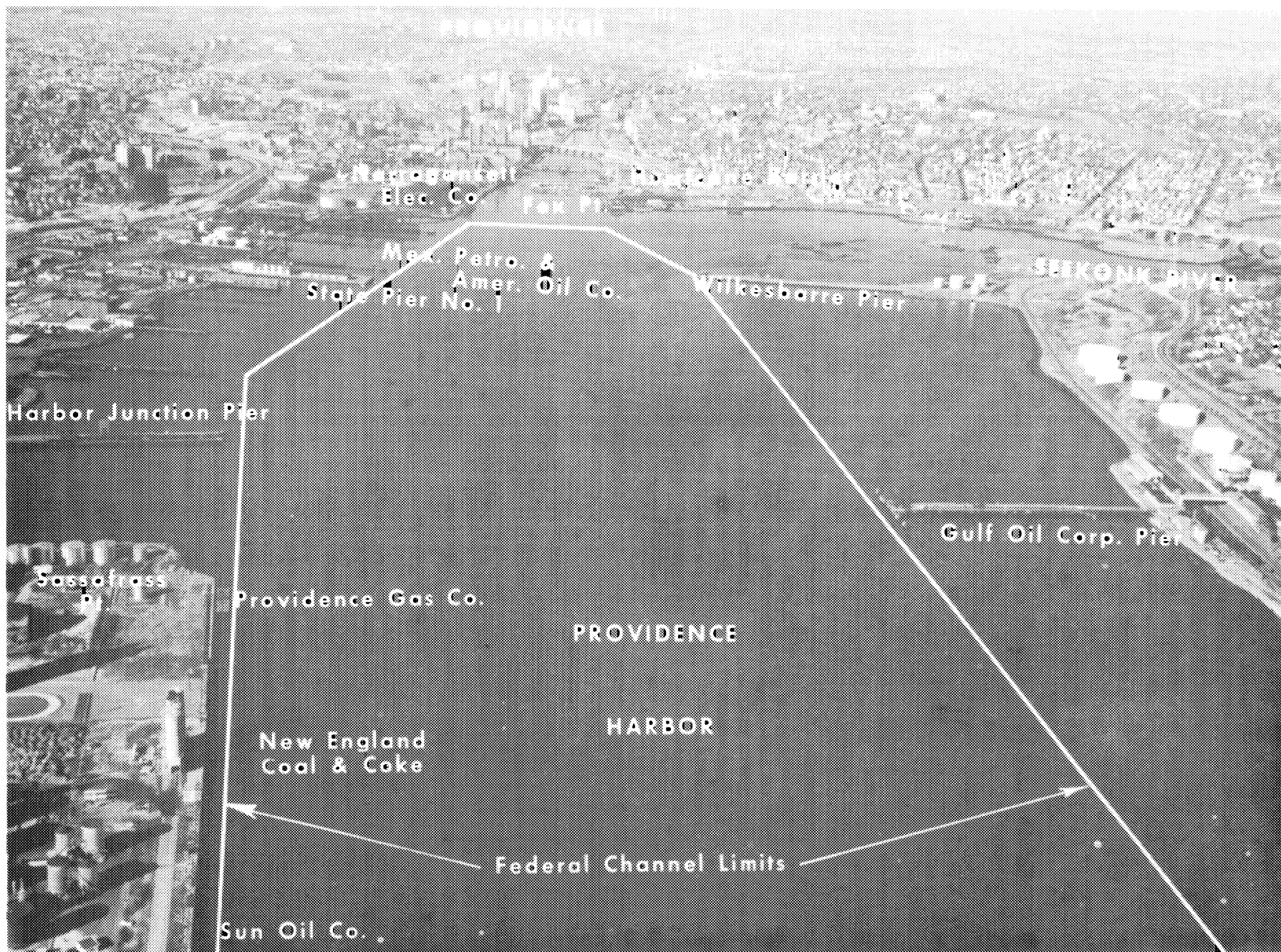


presently not used for handling waterborne commerce. Eighteen of these nineteen have connections with the New York, New Haven, and Hartford Railroad system.

18. At present there are ten wharves with major oil-handling facilities, with a combined petroleum storage capacity of about 9,000,000 barrels. On the East Providence side of the harbor are located the Socony-Mobil Oil Co. Wharf with 850 feet of usable berthing space 35 feet deep at M.L.W.; the Atlantic Refining Co. Wharf with 125 feet, 28 feet deep; the Mexican Petroleum Corp. and American Oil Co. Wharf with 600 feet, 30 feet deep; the Gulf Oil Corporation Pier which has been recently modified and the berth dredged to 35 feet; and the Wilkesbarre Pier with 890 feet, 35 feet deep. On the Providence side are the Narragansett Electric Co. facilities at Henderson Street with about 800 feet of berthing space, 33 feet deep at M.L.W.; the Mexican Petroleum Corp. and American Oil Co. Pier at the foot of Public Street with 620 feet, 30 feet deep; the Harbor Junction Pier, with a combined length of 1,000 feet, which is 35 feet on both the lower and upper sides; the Sun Oil Co. Wharf with 300 feet, from 25 to 30 feet deep, and the Municipal Wharf with 3800 feet, from 20 to 35 feet deep. The preceding facilities are owned or used by nine major oil companies, Socony-Mobil Oil Co., the Atlantic Refining Co., Mexican Petroleum Corp. and its affiliate the American Oil Co., Gulf Oil Corp., Esso Standard Oil Co., the Texas Co., Sun Oil Co., Tidewater Associated Oil Co., and Richfield Oil Co.

19. In addition to petroleum receipts, there are two major general cargo wharves, the Municipal Wharf owned by the City of Providence and State Pier No. 1 owned by the State of Rhode Island. Both have adequate storage accommodations and the Municipal Wharf is capable of handling the new deep-draft cargo vessels.

20. There are six piers which have coal-handling facilities, the Narragansett Electric Co. Pier at the foot of Henderson St. extended, the C. H. Sprague and Son Coal Pier at the foot of Rhodes St. extended, the Old Colony Wharf at the foot of O'Connell St. extended, the Harbor Junction Pier above Sassafras Pt., the Providence Gas Co. Wharf at Sassafras Pt., and the New England Coal & Coke Co. Wharf north of Field Point. One of these piers, the Narragansett Electric Co. Pier, already is used by a deep-draft collier, and two others, the C. H. Sprague and Son Coal Pier and the Harbor Junction Pier have facilities and berthing depths sufficient for the use of large colliers.



PROVIDENCE

Narragansett  
Elec. Co.

Fox Pt.

Wilkesbarre Pier

SEEKONK RIVER

Mex. Petro. &  
Amer. Oil Co.  
State Pier No. 1

Wilkesbarre Pier

Harbor Junction Pier

Sassafrazz  
Pt.

Providence Gas Co.

Gulf Oil Corp. Pier

PROVIDENCE

HARBOR

New England  
Coal & Coke

Federal Channel Limits

Sun Oil Co.







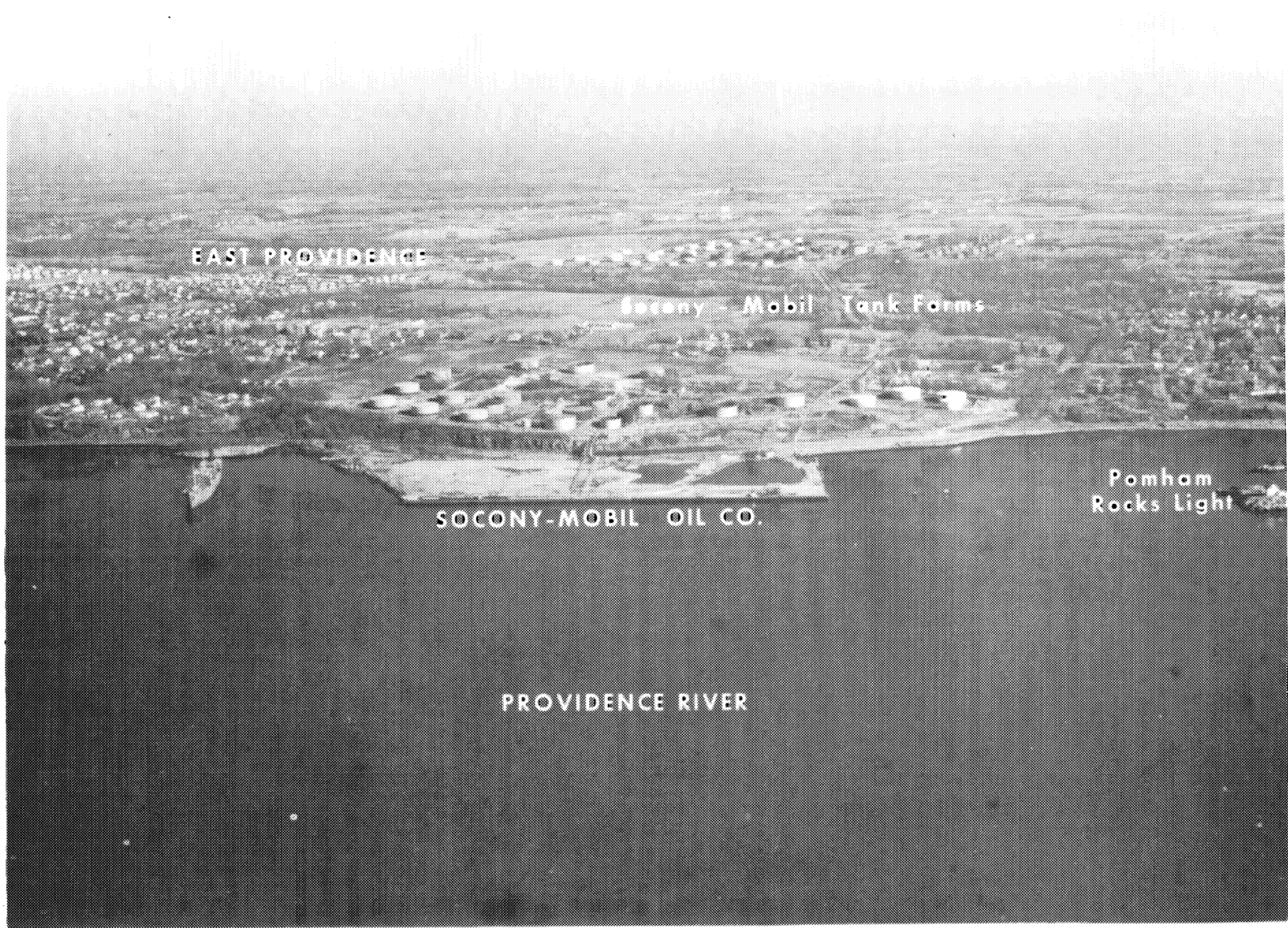
EAST PROVIDENCE

Mexican Petroleum and  
American Oil Co. Wharf

Atlantic Refining  
Co. Wharf

Fuller Rock Light

PROVIDENCE RIVER



EAST PROVIDENCE

Socony - Mobil Tank Farms

SOCONY-MOBIL OIL CO.

Pomham  
Rocks Light

PROVIDENCE RIVER

## IMPROVEMENTS DESIRED

21. In order to determine the nature and extent of further improvements desired by local interests, a public hearing was held at Providence, Rhode Island on 26 April 1960. Present at the hearing were officials of the State of Rhode Island and the City of Providence, representatives of shipping and terminal interests, local harbor pilots, representatives of civic groups, and other interested citizens. Local interests requested that the existing project be deepened to 40 feet and extended in a southerly direction to a point just south of Prudence Island Light and that the sharp bends be either straightened or eased to eliminate hazards to navigation. The most critical areas mentioned at the hearing were the section of the main channel from just below Sabin Pt. up to Fields Pt., the bend between the Conimicut and Bullock Point reaches, and the shoal just south of Prudence Island Light. It was also requested that the possibility of relocating the main channel to pass to the east of Sabin Pt. Light be investigated. In addition a channel 30 feet deep was requested to a point opposite the Tidewater Terminal and Stevedoring Co. wharf near India Point. This wharf is used for the export of scrap iron in Liberty ships. Deepening the India Point channel would permit these vessels to be fully loaded at this wharf.

22. Local desires for improvement are based on the importance of the port to the economy of the State of Rhode Island and the entire tributary area of the Port of Providence. Local interests feel that the existing project is inadequate to meet the present and prospective needs of the tributary area. Many of the vessels already using the harbor are subject to costly tidal delays and some of the operating oil companies own large tankers which they cannot use in the present channel due to the restrictive depth. These conditions are magnified by the trend towards larger deep-draft tankers. It is also felt that the sharp bends in the existing channel present an undue hazard to navigation and that a straighter alignment would also reduce the transit time from bay to dock and result in savings in ship time and in standby charges on dock personnel.

23. The City of East Providence reports that over 1,000 acres of the City's industrial land is linked to or directly dependent upon port facilities. At present these port related activities represent an investment of over \$15,000,000 in land and structures to East Providence. In addition to directly related port activities, the future growth rate of the entire tributary area will be influenced by the economy of fuel consumption. Comparatively high fuel costs will act as a deterrent to future industrial growth.

Local interests feel that a 40-foot deep channel with improved navigating conditions is essential to assure the continued economic growth of the tributary area.

#### EXISTING AND PROSPECTIVE COMMERCE

24. The principal items of commerce for Providence River and Harbor are petroleum and petroleum products, bituminous coal and lignite, iron and steel scrap, lumber and shingles, and building cement. All other items were less than 1% of the total commerce in 1960. The total tonnages for the Port of Providence for the period 1951 to 1960 are listed below:

<u>Year</u>	<u>Tonnage (Short Tons)</u>	<u>Year</u>	<u>Tonnage (Short Tons)</u>
1951	7,968,843	1956	8,227,047
1952	7,774,174	1957	7,903,027
1953	7,598,269	1958	7,889,434
1954	7,439,820	1959	8,275,928
1955	7,696,271	1960	7,949,820

25. Petroleum and petroleum products constitute almost 90% of the commerce moved in the harbor. In 1960 there were about six and three-quarter million short tons of waterborne petroleum receipts. This is expected to increase to almost 20,500,000 tons by the year 2068 (See Appendix B). The export of scrap, although still constituting only a minor portion of the total commerce, has increased from about 24,000 short tons in 1953 to almost 130,000 short tons in 1961. Almost all of this scrap is shipped from the Tidewater Terminal & Stevedoring Co. wharf at India St. Scrap iron is used in the manufacture of low-grade iron products, because it requires less processing than raw iron ore. Due to the shortage of iron ore and scrap iron in some foreign countries, it is expected that the export of iron scrap will undergo a moderate increase in future years.

#### VESSEL TRAFFIC

26. Almost all the deep-draft vessel traffic in the main channel of the Port of Providence in recent years has been composed of oil tankers. The largest incoming tanker in 1948 was in the T-2 class, about 16,700 dwt. with a draft of about 31 feet. When the existing project was completed in 1949 the draft of the largest incoming tanker jumped to 33 feet. Since that time vessels drawing over 36 feet of water have been recorded as using the channel. Shippers have found



that it is more economical to use the larger tankers even with costly tidal delays. Several of the oil companies operating in Providence River & Harbor already own vessels which are too large to navigate safely in the existing channel, and others have similar size vessels under contract or construction. The American Merchant Marine Institute, Inc. reports that a 40-foot channel would enable vessels with loaded drafts of 35 feet to about 40 feet to operate on the waterway, the former at all stages of tide and the latter on high tide.

27. Vessels engaged in scrap iron commerce in this harbor are in the Liberty or the "Jumboized" Liberty class. Both classes have similar drafts (about 28 feet), the former holding about 9,300 long tons of scrap, and the latter, about 11,300 long tons. The average age of present Liberty ships is 15 to 20 years, so it is expected that future scrap iron commerce will be carried in vessels similar to the "Jumboized" or renovated Liberty ships. The only dock, currently used for this commerce, is the India St. dock, which loaded 10 vessels in 1959, 13 in 1960, and 14 in 1961. Due to anticipated increases in scrap iron exports it is expected that vessel traffic at this dock will increase.

#### DIFFICULTIES ATTENDING NAVIGATION

28. The major difficulties attending navigation are due to the sharp bends in the existing 35-foot channel and the lack of sufficient depth for large tankers. The most critical bends are the one opposite Sabin Point Light, the one immediately above Conimicut Point, the one between the Fuller Rock and Sabin Point reaches, and the bend at North Point. At present the channel has sufficient width to accommodate adequately two-way or two-lane traffic for even the large supertankers, however the sharp bends are hazardous. At present the bend opposite Sabin Point has a two-lane minimum radius of only 600 feet, compared with the 7,000-foot minimum radius which was recommended by the Corps of Engineers in their model investigations for the Panama Canal sea-level project. The other critical bends listed above have minimum two-lane radii varying from 2,500 feet to 4,500 feet. In the past the 600-foot existing Federal channel compensated for the sharpness of the bends, but at present, and especially in the future as large supertankers become more common, the full width of channel will be required for navigation and the effect of the bends on navigation will be magnified.

29. The 35-foot channel is presently being used by vessels drawing up to 38 feet, even though vessels over 31-foot draft are subject to tidal delays. The largest vessels are operating with a clearance of only 2 feet at high tide, when a clearance of 5 feet



is considered necessary for safe navigation. There have been several reports of groundings in the existing channel.

30. The Liberty ships used in scrap metal exports draw about 28 feet when fully loaded. As the controlling depth in the India Pt. channel is only 22 feet, these vessels can only be partially-loaded at the India St. dock of the Tidewater Terminal and Stevedoring Co. The vessels must then be shifted to Field Pt. for complete loading.

#### WATER POWER AND OTHER SPECIAL SUBJECTS

31. There is a hurricane barrier being constructed across the Providence estuary, but it is above the limits of the existing project and will have no adverse effect on commercial navigation in the port. There are no water or flood control aspects which pertain to the considered improvements. The considered improvements will have no significant adverse effect on fish and wildlife, irrigation, or recreation.

#### PLAN OF IMPROVEMENT

32. The proposed plan of improvement, shown on the maps accompanying this report, includes deepening the existing 35-foot channel to 40 feet and extending it in a southerly direction about five miles to a point just south of Prudence Island Light. The plan includes easing the critical bends by increasing the minimum radius for two-lane traffic to at least 5,000 feet. This would require the removal of Sabin Point Light, and the construction of a new light structure to the east of the proposed channel limit. In addition the plan includes deepening India Pt. channel to 30 feet for a width of 150 feet, to a point opposite the Tidewater Terminal and Stevedoring Co. wharf.

33. For modification of the existing 35-foot channel, two other depths were also considered, a 38-foot and a 42-foot. The annual benefits and charges, and benefit-cost ratios of both depths as compared with the 40-foot depth, are discussed under Comparison of Benefits and Costs. The 40-foot depth of channel was judged to be the most economical depth. Consideration also was given to the desire of local interests to relocate the channel to the east of Sabin Point Light. Although such a relocation would provide a shorter, straighter and safer channel alignment preliminary studies indicated that it would add about \$4,000,000 to the project cost. The time saving and reduced operating cost for the relocated channel would not justify such an expense.

34. The possibility of a deep-water terminal in Narragansett Bay with a pipeline to Providence was also investigated. Preliminary studies indicated that there would be a high initial investment for the terminal development plus prohibitive costs for a pipeline system. There would be difficulty in finding a suitable terminal site near to deep water and yet close enough to Providence to facilitate economic pumping operation. In addition deliveries of residual oil would have to be seasonal due to the difficulty of pumping high viscosity fluids during below-freezing periods. The cost of a deep-water terminal and the required pipelines would be much greater than the cost of a channel improvement.

35. Consideration was also given to the possibility that long distance pipeline transmission of petroleum products would reduce deep draft tanker traffic into Providence Harbor. Available data on the Colonial pipeline from Texas refineries to New York indicates that delivery costs by pipeline might be competitive where only T-2 tankers are used. There appears to be an economic advantage for the pipeline to inland cities where secondary transportation from the nearest port is now required. However, delivery costs to Providence in larger tankers are now substantially less than T-2 costs, and it does not appear that future pipelines will become competitive with the large tankers now coming to Providence. In any case a deeper channel will be needed for tankers bringing in foreign oil. For further discussion see Appendix D of this report.

36. Local interests have been consulted for their comments on the proposed plan, and concur that it will meet their present and future needs for navigation.

#### SHORELINE CHANGES

37. The improvements considered would have no effect on the configuration of the shoreline.

#### REQUIRED AIDS TO NAVIGATION

38. The United States Coast Guard has been consulted and has indicated that additional aids to navigation will be required for the proposed plan of improvement. The estimated cost of removing the existing light structure at Sabin Point is \$20,000 and the estimated cost of a new light structure to the east of the proposed channel is \$28,000 minus \$3,500 salvage from the existing Light structure. Additional aids to navigation for the rest of the improvement are estimated at \$33,500. The total first costs and

annual maintenance costs for the additional aids considered necessary are as follows:

First Costs

New Light structure at Sabin Point	\$28,000
Salvage value-existing light	-3,500
Other additional aids	<u>33,500</u>
Total	\$58,000
<u>Annual Maintenance</u>	\$ 2,900

ESTIMATES OF FIRST COST

39. Estimates of first cost of the considered and proposed plan of improvement have been made and are tabulated in Appendix A of this report. Dredging quantities are in terms of in-place measurement with a 2-foot overdepth allowance. The materials to be encountered include both rock and ordinary material, and the required grade for rock was taken as two feet below project depth. All material was assumed to be removed by bucket dredge, placed in a scow and towed to a dumping ground in the ocean south of Narragansett Bay. Side slopes were assumed to be 1 vertical on 1 horizontal in rock and 1 vertical on 3 horizontal in ordinary material. Estimates of first cost are based on prices prevailing in December 1962 and are tabulated below for the proposed 40-foot improvement.

First Costs - December 1962

40'  
Channel

Dredging, rock removal, and Removal of Sabin Pt. Lt. (including contingencies)	\$13,214,000
Engineering and Design	156,000
Supervision and Administration	<u>530,000</u>
TOTAL COSTS (Corps of Engineers)	\$13,900,000 *

\* Excludes \$57,000 already expended on preauthorization studies.

Coast Guard Additional Aids to Navigation	\$ <u>58,000</u>
TOTAL FEDERAL FIRST COST	\$13,958,000

## ESTIMATES OF ANNUAL CHARGES

40. The estimated annual charges have been computed for the proposed improvement for both a 50-year and a 100-year life-of-project. An interest rate for Federal investment of 2.875 percent was used in computing annual charges, with 0.919 percent for amortization over a 50-year period and 0.179 percent over a 100-year period.

41. Estimates of the additional annual maintenance dredging to be performed were based on experienced rates of shoaling in the existing channel. Estimates of additional annual maintenance to navigation aids were supplied by the U. S. Coast Guard. The estimate of the probable length of the construction period is based on the capacities of available large bucket-type dredges. Interest during the construction period was computed at the Federal interest rate of 2.875 percent.

42. The estimates of annual charges for the proposed channel improvements are \$586,200 for a 50-year life of project and \$477,200 for a 100-year life of project.

## ESTIMATES OF BENEFITS

43. Benefits for the main channel have been based on the savings in transportation costs of petroleum products by the use of larger oil tankers. Benefits to the India Pt. channel have been based on the elimination of additional vessel charges and the reduction in loading costs caused by the present practice of loading at two terminals. Detailed estimates of the savings expected to accrue to the proposed improvements are described and tabulated in Appendix B of this report.

44. Benefits to main channel. Future increases in petroleum consumption and the trend toward larger tankers which is already prevalent, indicate that more petroleum will enter Providence Harbor in the future and that substantial savings can be made by using ships which are too large to navigate the existing channel.

45. The total waterborne receipts of petroleum and petroleum products in 1960 was 6,258,300 short tons. This is expected to increase to approximately 7,010,000 in 1968, 14,630,000 in 2018 and 20,500,000 in 2068. At present 45% of the petroleum receipts is carried in deep-draft tankers which experience tidal delay. This percentage is anticipated to increase to 50% in 1968, 60% in 2018, and 70% by 2068, if the main channel is not improved, due to the

fact that larger vessels are more economical even with the tidal delay involved. If the channel is improved to a 40-foot depth, it is expected that these same deep-draft vessel sizes will increase so that by the year 2018, half the deep-draft commerce will be carried in tankers which average 35,000 dwt and half in tankers which average 53,000 dwt.

46. Savings anticipated in future years were reduced to equivalent annual benefits, and as growth was conservatively projected on a straight-line basis, the savings were reduced to present worth at 2.875% and then converted to annual benefits. The annual benefits for the proposed 40-foot project were estimated to be \$765,500 for a 50-year life-of-project and \$967,100 for a 100-year life-of-project.

47. Definite intangible benefits will result from easing the bends in the existing channel. No monetary value has been placed on the effect of the proposed smoother bends, however the larger radii should result in savings both in operating costs and also in the reduction in hazards to navigation. In the past there have been many instances when incoming tankers have almost run aground due to the sharpness of the channel bends. No serious mishaps have occurred as yet, but there is a strong possibility that a serious catastrophe could occur unless the radii of the critical bends are lengthened.

48. Benefits to India Pt. Channel. The Tidewater Terminal and Stevedoring Company and its associate company, General Scrap Iron Inc., export scrap iron from their dock on the India Pt. channel. In recent years almost all the exports of this material from Providence River and Harbor have been made from this dock. Tonnages from this terminal have fluctuated from 61,000 long tons in 1959 to a high of 111,000 long tons in 1961. The average annual shipment for the past four years has been approximately 85,000 long tons. Due to the available world markets for scrap iron, as a substitute for iron ore in the production of low grade steel products, it is expected that more scrap will be exported if the India Pt. channel is improved. In the computation of benefits it has been conservatively assumed that exports from this India St. dock will average 100,000 long tons annually in the future.

49. The Liberty and Jumboized Liberty ships which are currently engaged in this commerce are not able to be fully-loaded due to the shallow condition of the India Pt. channel. These vessels can be only partially loaded at India St. and then must be shifted to the Municipal Wharf at Field Pt. to complete their cargo.

The cargo required to complete the loading at Field Pt. must be shifted from the India St. terminal by truck to Field Pt. In addition the loading facilities at Field Pt. are much less efficient than those at the India St. terminal. Extra costs are incurred in shifting vessels to Field Pt., in dockage and wharfage fees at Municipal Wharf, in trucking cargo between terminals, and in the reduced loading efficiency at Municipal Wharf.

50. Construction of the desired India Pt. channel 30 feet deep and 150 feet wide would permit loading of full cargoes at the India St. terminal. The total annual benefits expected to accrue as a result of the elimination of shifting and loading vessels at a second terminal are \$22,800.

51. Total Benefits - Recommended Project. The total annual benefits for the combined improvements, the 40-foot main channel and the 30-foot India Pt. channel, are as follows:

	<u>50 yr. life</u>	<u>100 yr. life</u>
40-foot Main Channel	\$765,500	\$967,100
30-foot India Pt. Channel	<u>22,800</u>	<u>22,800</u>
Total Annual Benefits	\$788,300	\$989,900

#### COMPARISON OF BENEFITS AND COSTS

52. Main Channel. Comparisons of annual benefits to annual costs for the proposed 40-foot improvement and also the considered 38 and 40-foot improvements to the main channel for a 50 and a 100-year project life are tabulated below.

	<u>38'</u> <u>Channel</u>	<u>40'</u> <u>Channel</u>	<u>42'</u> <u>Channel</u>
<u>50-Year Life</u>			
Annual Benefits	\$521,200	\$765,500	\$841,800
Annual Costs	356,500	574,700	808,600
Benefit-Cost Ratio	1.5	1.3	1.04
<u>100-Year Life</u>			
Annual Benefits	\$649,900	\$967,100	\$1,066,000
Annual Costs	291,300	466,900	655,200
Benefit-Cost Ratio	2.2	2.1	1.6

53. Although the benefit-cost ratio for the 42' channel is unity or greater, the additional costs of deepening from 40 to 42 feet are greater than the benefits received. On the same basis the 40-foot channel appears more economically feasible than the 38-foot channel, because the additional benefits are greater than the cost of dredging the additional two feet.

54. India Pt. Channel. Comparison of annual benefits to annual costs for the proposed 30-foot improvement to the India Pt. channel for a 50 and a 100-year project life are as follows:

	<u>50-Year Life</u>	<u>100-Year Life</u>
Annual Benefits	\$22,800	\$22,800
Annual Costs	<u>12,100</u>	<u>10,700</u>
Benefit-Cost Ratio	1.9	2.1

55. Recommended Improvement. The comparison of annual benefits to annual charges for the combined 40-foot main channel and the 30-foot India Pt. Channel, for a 50 and a 100-year life are as follows:

	<u>50-Year Life</u>	<u>100-Year Life</u>
Annual Benefits	\$788,300	\$989,900
Annual Costs	<u>586,200</u>	<u>477,200</u>
Benefit-Cost Ratio	1.3	2.1

#### PROPOSED LOCAL COOPERATION

56. The benefits to be derived from the improvements considered are general in nature and as such no cash contribution by local interests is required toward the first cost of construction of the project. However, in order to realize fully the benefits anticipated to accrue to the main channel, it is considered that those major oil-handling berths now used by the majority of the deep-draft commerce should be deepened to depths commensurate with the considered 40-foot project depth. It is also considered necessary that the berth of the India St. terminal be deepened to a depth commensurate with the considered 30-foot deep India Pt. channel improvement. Reasonable assurances of compliance with these requirements have been received.

57. In addition to berth improvements it is proposed, and local interests have agreed, to hold and save the United States free from damages that may result from construction and maintenance of the project.

#### APPORTIONMENT OF COSTS AMONG INTERESTS

58. As the benefits from the considered improvements would accrue to commercial navigation, annual charges have been computed on the basis that the costs of channel improvements will be entirely borne by the United States and the berth improvements by local interests.

#### COORDINATION WITH OTHER AGENCIES

59. All Federal, state and local agencies having interest in the improvement of Providence River and Harbor were notified of the public hearing held at Providence 26 April 1960. The U. S. Coast Guard, the U. S. Fish and Wildlife Service, representatives of the State of Rhode Island and the City of Providence have been consulted during the study concerning the considered 40-foot improvement.

#### DISCUSSION

60. Providence River and Harbor is a tidal estuary extending from the northerly end of Narragansett Bay inland to the City of Providence. The upper two and a half miles, comprising the harbor proper, is 35 feet deep for widths varying up to 1,700 feet, excluding a marginal strip 75 feet wide channelward of the established harbor lines. The 8.1 mile approach channel starts in deep water in Narragansett Bay opposite North Point on Popasquash Neck and runs north to Pomham Rocks at a 600-foot width and 35-foot depth.

61. Almost ninety percent of the waterborne commerce in Providence Harbor is petroleum and petroleum products. In 1960 the waterborne petroleum receipts from foreign and coastwise ports totalled over six and a quarter million short tons. Due to anticipated increases in population and per capita consumption, this total is expected to reach over 14,500,000 short tons by the year 2018 and almost 20,500,000 tons by 2068.

62. At present 45% of the ocean-borne petroleum receipts moves in deep draft vessels which experience tidal delays. In the future with the current trend toward larger and larger tankers, it is expected that even greater percentages will be carried in the larger



classes of vessels, which draw too much water to navigate the existing channel. If the channel is deepened to 40 feet it is anticipated that there will be an immediate increase in the size of tankers using this port. This increase is conservatively expected to continue at a gradual rate until the year 2018 when about 70% of the ocean-borne petroleum receipts will be carried in deep-draft vessels, one half in vessel classes averaging 35,000 dwt and one half in vessel classes averaging 53,000 dwt.

63. The Federal project channel will not be adequate to meet the needs of prospective shipping unless it is deepened and unless the critical bends are eased. Studies were made of deepening the channel to 38, 40 or 42 feet. All three had benefit-cost ratios greater than unity, but the 42-foot channel was judged incrementally uneconomical in that the cost of dredging the additional two feet (from 40 to 42) exceeded the additional benefits.

64. A study was made of the desire of local interests to straighten the upper end of the approach channel by relocating it to the east of Sabin Point Light. The cost of dredging to accomplish this made the improvement economically unfeasible. Instead, all the critical bends were eased so that the minimum radius for two-lane traffic is 5,000 feet.

65. Consideration was given to alternate methods of transportation and sources of fuel. Thus forecasts of petroleum consumption are conservative because of the possibility that other fuel and energy sources could supply a portion of this demand. Studies of overland methods of transportation showed that water carriers are the most economical method for delivering petroleum to Providence River and Harbor.

66. In addition to an improvement in the main channel, local interests requested a 30-foot depth in the India Pt. channel. Exports of scrap metal in Liberty ships from a terminal near India Pt. are hindered by inadequate depths in the channel. Vessels can only be loaded partially and then must be shifted to Field Pt. to complete loading. This results in additional costs in shifting vessels to Field Pt., in dockage and wharfage fees at Municipal Wharf, in trucking cargo between terminals, and in reduced loading efficiency at Municipal Wharf.

67. A 30-foot channel improvement, 150 feet wide, would be sufficient to permit full-loading at the India St. terminal and eliminate the additional charges, now incurred by the scrap iron commerce. As an alternate to this improvement, consideration was

given to the possibility of General Scrap Iron, Inc. moving its entire operation to some location where a deeper berth was already available. The cost of this alternative would far exceed the proposed improvement.

68. To insure realization of the estimated benefits it is considered that those berths now used by the majority of the deep-draft commerce in the Main channel, and the berth owned by General Scrap, Inc. on the India Pt. Channel, should be deepened to depths commensurate with the proposed project depths. The estimated cost of deepening these berths is \$325,000 and is considered self-liquidating.

69. The 40-foot improvement to the Main Channel and the 30 foot improvement to the India Pt. Channel would require a Federal investment, including interest during construction, of \$14,743,000. The benefit-cost ratio for this improvement is 1.3 based on a 50-year life-of-project, and 2.1 based on a 100-year life-of-project.

#### CONCLUSION

70. The Division Engineer concludes that the 40-foot improvement to the Main Channel, and the 30-foot improvement to the India Pt. Channel, as requested by local interests, best meet the needs of navigation and are economically justified. He further concludes that the proposed easing of the critical bends is necessary to reduce hazards to navigation.

71. The proposed improvement can be accomplished at a construction cost of \$13,958,000 to the Federal Government, including \$58,000 for additional navigation aids. Not included are pre-authorization studies which have cost \$57,000. Additional annual maintenance costs are estimated at \$24,000 for dredging and \$2,900 for additional navigation aids. Local costs for improvements to berths are estimated at \$325,000.

#### RECOMMENDATION

72. The Division Engineer recommends that the existing project be modified to provide a main channel 40 feet deep and generally 600 feet wide into Providence Harbor, and a channel 30 feet deep and 150 feet wide along the India St. waterfront, as shown on the maps accompanying this report, at an estimated cost of \$13,900,000, subject to the requirement that no construction work on the project shall be accomplished until local interests agree to:

(a) Hold and save the United States free from damages due to the construction and maintenance of the project.

(b) Provide and maintain without cost to the United States depths in berthing areas commensurate with the project depths.

P. C. HYZER  
Colonel, Corps of Engineers  
Division Engineer

## APPENDIX A

### ESTIMATES OF FIRST COST AND ANNUAL CHARGES

1. General. This appendix presents detailed estimates on the first cost and annual charges of the considered improvements of Providence River and Harbor. The improvements are described in detail in the main report and consist chiefly of extending the existing channel to the south, deepening it to either 38, 40, or 42 feet, and also easing the bends in the channel to a minimum two-lane traffic radius of 5,000 feet; and also deepening India Pt. channel to 30 feet for a width of 150 feet.

2. Cost Estimates. Cost estimates are shown separately for the three considered depths of channel - 38, 40, and 42 feet - for modification of the existing 35-foot main channel; and also separately for deepening the India Pt. channel. The required grade for rock was taken as two feet below project depth. The detailed estimates of first cost include the costs for construction, contingencies, engineering and design, and supervision and administration. Estimates of the annual costs of the improvements include interest and amortization over the life of the project, and costs of additional annual maintenance.

3. Materials. The materials to be encountered in providing the considered improvements include both rock and ordinary material. All material was assumed to be removed by bucket dredge, placed in a scow and towed to a dumping ground in the ocean just south of Narragansett Bay.

4. Unit Prices. The unit prices for dredging used in the estimates of construction were based on recently experienced costs of similar work in the area. Estimates of the costs of navigation aids to be relocated and constructed for the various considered improvements and the estimates of maintenance were furnished by the U. S. Coast Guard.

5. Interest Rates. An interest rate of 2.875 per cent for Federal investment was used in computing the annual charges, with 0.919 per cent for amortization over a 50-year period, and 0.179 per cent over a 100-year period.

6. Maintenance. Estimates of the quantities of maintenance dredging to be removed annually were based on experienced rates of shoaling of the existing channel.

7. Overdepth and Side Slopes. All estimates of quantities of dredging include two feet of overdepth in the channels. Side slopes were assumed to be: 1 vertical on 1 horizontal in rock, and 1 vertical on 3 horizontal in ordinary material.

8. Contingencies, Engineering and Administration. All allowances to cover contingencies during construction, engineering and design, and supervision and administration are estimated on the basis of past experience in the area. An additional allowance was included in the engineering costs for detailed studies of possible spoil areas in the vicinity of the project.

9. Preauthorization Survey and Study Costs. The sum of \$57,000 has been expended for preauthorization survey and study costs.

10. Berth Improvements. At present there are ten wharves with major oil-handling capabilities, on the 35-foot main channel. These wharves are listed below:

East Providence

Socony-Mobil Oil Company Wharf  
Atlantic Refining Company Wharf  
Mexican Petroleum Corporation and American Oil Company  
Wharf - (Kettle Pt.)  
Gulf Oil Corporation Pier  
Wilkesbarre Pier

Providence

Mexican Petroleum Corporation and American Oil Company  
Pier - (Public St.)  
Harbor Junction Pier  
Narragansett Electric Company (below Fox Pt. barrier)  
Sun Oil Company Wharf  
Municipal Wharf

It is not necessary that all ten be improved to assure full use of a deeper channel. It is expected that the more important berths will be dredged immediately. Competition will result in improvement to the other berths over the life of the project as larger vessels come into use. The estimated costs of dredging those berths now used by the majority of the deep-draft vessels to depths commensurate with the considered project depths are: \$200,000, \$275,000 and \$350,000 respectively, for 38', 40', and 42' channels.

On the India Pt. channel there is only one wharf currently engaged in commerce. This wharf, with a berth depth of 35 feet, is

owned by the Tidewater Terminal and Stevedoring Co. To insure the anticipated benefits this berth would have to be deepened to a depth commensurate with the proposed 30-foot channel. The estimated cost of this dredging is \$50,000.

11. Detailed estimates were made separately for the 38, 40, and 42-foot modifications in depth to the main channel and for the 30-foot India Pt. channel. Cost estimates are based on prices prevailing in December 1962.

# MAIN CHANNEL

## PROJECT COST ESTIMATES

Cost Account Number	38' <u>Channel</u>	40' <u>Channel</u>	42' <u>Channel</u>
09 CHANNELS			
Dredging	5,000,000 @ \$1.30 \$6,500,000	8,800,000 @ \$1.20 10,560,000	12,900,000 CYs @ \$1.15 14,835,000
Rock Removal	12,000 @ \$30.00 \$360,000	25,000 @ \$30.00 750,000	45,000 CYs @ \$30.00 1,350,000
Removal of Sabin Pt. Light Contingencies @ 15%	20,000 \$1,035,000	20,000 1,700,000	20,000 2,435,000
29 PRE-AUTHORIZATION STUDIES	55,000	55,000	55,000
30 ENGINEERING AND DESIGN	140,000	150,000	160,000
31 SUPERVISION AND ADMINISTRATION	335,000	520,000	740,000
TOTAL COSTS (Corps of Engrs)	\$8,445,000	13,755,000	19,595,000
Non-Federal Contributions	0	0	0

MAIN CHANNEL Cont'dNON-FEDERAL COSTS

	38' <u>Channel</u>	40' <u>Channel</u>	42' <u>Channel</u>
Lands and Damages	0	0	0
Relocations	0	0	0
Berth Improvements (Self-liquidating)	<u>\$200,000</u>	<u>275,000</u>	<u>350,000</u>
Total Non-Federal Costs	\$200,000	275,000	350,000

SUMMARY OF ESTIMATED COSTS

	38' <u>Channel</u>	40' <u>Channel</u>	42' <u>Channel</u>
Federal Costs			
Corps of Engineers	<u>\$8,445,000</u>	13,755,000	19,595,000
Coast Guard	<u>53,000</u>	<u>53,000</u>	<u>53,000</u>
Total Federal	\$8,498,000	13,808,000	19,648,000
Required Non-Federal Costs	<u>200,000</u>	<u>275,000</u>	<u>350,000</u>
TOTAL FEDERAL AND REQUIRED NON-FEDERAL COSTS	\$8,698,000	14,083,000	19,998,000

INDIA POINT CHANNEL

## PROJECT COST ESTIMATE

Cost

Account  
Number

09 CHANNELS		
Dredging	135,000 c.y. @ \$1.20	\$160,000
Contingencies @ 15%		24,000
29 PRE-AUTHORIZATION STUDIES		2,000
30 ENGINEERING AND DESIGN		6,000
31 SUPERVISION AND ADMINISTRATION		<u>10,000</u>
TOTAL COSTS (Corps of Engineers)		\$202,000
Non-Federal Contributions		0

INDIA POINT CHANNEL Cont'dNON-FEDERAL COSTS

Lands and Damages	0
Relocations	0
Berth Improvements (self-liquidating)	<u>\$50,000</u>
Total Non-Federal Costs	\$50,000

SUMMARY OF ESTIMATED COSTS

Federal Costs	
Corps of Engineers	\$202,000
Coast Guard	<u>5,000</u>
Total Federal	\$207,000
Required Non-Federal Costs	<u>50,000</u>
TOTAL FEDERAL AND REQUIRED NON-FEDERAL COSTS	\$257,000

SUMMARY OF COSTS FOR RECOMMENDED PROJECT

(40-Foot Main Channel and 30-Foot India Pt. Channel)

Cost  
Account  
Number

09 CHANNELS	
Dredging 8,935,000 c.y. @ \$1.20	\$10,720,000
Rock Removal 25,000 c.y. @ \$30.00	750,000
Removal of Sabin Pt. Light	20,000
Contingencies	<u>1,724,000</u>
29 PRE-AUTHORIZATION STUDIES	57,000
30 ENGINEERING AND DESIGN	156,000
31 SUPERVISION AND ADMINISTRATION	<u>530,000</u>
TOTAL COSTS (Corps of Engineers)	\$13,957,000
Non-Federal Contributions	0



SUMMARY OF COSTS FOR RECOMMENDED PROJECT Cont'd

NON-FEDERAL COSTS

Lands and Damages	0
Relocations	0
Berth Improvements (Self-liquidating)	<u>\$325,000</u>
Total Non-Federal Costs	\$325,000

SUMMARY OF ESTIMATED COSTS

Federal Costs	
Corps of Engineers	\$13,957,000
Coast Guard	<u>58,000</u>
Total Federal	\$14,015,000
Required Non-Federal Costs	<u>325,000</u>
TOTAL FEDERAL AND REQUIRED NON-FEDERAL COSTS	\$14,340,000

12. Estimates of Annual Charges. The estimates of Federal investment and annual charges for the considered improvements are shown below:

MAIN CHANNEL

	<u>38'</u> <u>Channel</u>	<u>40'</u> <u>Channel</u>	<u>42'</u> <u>Channel</u>
<u>Federal Investment</u>			
First Cost - Corps of Engrs excluding preauthorization studies	\$8,390,000	\$13,700,000	\$19,540,000
Interest during Construction @ 2-7/8% / year	3 yrs 360,000	4 yrs 790,000	4 yrs 1,125,000
First Cost - Coast Guard	<u>53,000</u>	<u>53,000</u>	<u>53,000</u>
TOTAL FEDERAL INVESTMENT	\$8,803,000	\$14,543,000	\$20,718,000

MAIN CHANNEL Cont'd

Federal Annual Charges - - - 50-year life

	38' <u>Channel</u>	40' <u>Channel</u>	42' <u>Channel</u>
Interest on Investment @ 2-7/8%	\$253,100	\$418,100	\$595,600
Amortization @ 0.919%	81,000	133,600	190,600
Annual Maintenance Navigation Aids	2,400	2,400	2,400
Additional Channel Maint.	<u>20,000</u>	<u>20,000</u>	<u>20,000</u>
FEDERAL ANNUAL CHARGES (50-year life)	\$356,500	\$574,100	\$808,600

Federal Annual Charges - - - 100-year life

	38' <u>Channel</u>	40' <u>Channel</u>	42' <u>Channel</u>
Interest on Investment @ 2-7/8%	\$253,100	\$418,100	\$595,600
Amortization @ 0.179%	15,800	26,000	37,200
Annual Maintenance Navigation Aids	2,400	2,400	2,400
Additional Channel Maint.	<u>20,000</u>	<u>20,000</u>	<u>20,000</u>
FEDERAL ANNUAL CHARGES (100-year life)	\$291,300	\$466,500	\$655,200

<u>Non-Federal Annual Charges</u> (50-year & 100-year life)	0	0	0
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TOTAL FEDERAL AND NON-FEDERAL  
ANNUAL CHARGES

50-year life	\$356,500	\$574,100	\$808,600
100-year life	291,300	466,500	655,200

# INDIA POINT CHANNEL

## Federal Investment

First Cost - (excluding pre-authorization studies)	\$200,000
<u>Federal Annual Charges - - - 50-year life</u>	
Interest on investment @ 2.875%	\$ 6,670
Amortization @ 0.919%	2,130
Annual Maintenance	
Channel	4,000
Navigation Aids	500
FEDERAL ANNUAL CHARGES (50-year life)	<u>\$ 13,300</u>
<u>Non-Federal Annual Charges</u>	<u>0</u>
<u>TOTAL FEDERAL AND NON-FEDERAL ANNUAL CHARGES - 50-year life</u>	<u>\$ 13,300</u>
<u>Federal Annual Charges - - - 100-year life</u>	
Interest on investment @ 2.875%	\$ 5,800
Amortization @ 0.179%	400
Annual Maintenance	
Channel	4,000
Navigation Aids	500
FEDERAL ANNUAL CHARGES (100-year life)	<u>\$ 10,700</u>
<u>Non-Federal Annual Charges</u>	<u>0</u>
<u>TOTAL FEDERAL AND NON-FEDERAL ANNUAL CHARGES - 100-year life</u>	<u>\$ 10,700</u>

## SUMMARY OF ANNUAL CHARGES FOR RECOMMENDED PROJECT

(40-Foot Main Channel and 30-Foot India Pt. Channel)

	<u>50-year life</u>	<u>100-year life</u>
Federal Annual Charges	\$586,200	\$477,200
Non-Federal Annual Charges	<u>0</u>	<u>0</u>
TOTAL ANNUAL CHARGES	\$586,200	\$477,200

## APPENDIX B - ECONOMICS

1. General. - This appendix describes the studies and analyses made to evaluate the benefits resulting from deepening both the main navigation channel into Providence Harbor and also the India Pt. channel. The improvements are presented in detail in the report and shown on the report maps.

2. The main or existing project channel, which is 35 feet deep and generally 600 feet wide, is adequate for navigation by all vessels except the larger tankers. The significant benefit from channel improvement is the reduction of tidal delays to tankers now in use, and the capability of using larger tankers. Therefore, benefits have been evaluated on the reduction in the transportation costs of petroleum and petroleum products in deep-draft tankers. The benefits depend on the projection of future petroleum commerce for Providence River and Harbor and the sizes of future tankers that will be used. The volume of petroleum commerce has been based upon the needs of the tributary population of the harbor. As the India Pt. channel is not affected by petroleum commerce, the benefits for it are computed separately, beginning on page 12 of this appendix.

3. Population of the Tributary Area. - The tributary area for the Port of Providence was determined by the use of freight rates on petroleum products. In general this area includes almost 90% of the State of Rhode Island, and extends into the northeast corner of Connecticut and into south central Massachusetts. It is estimated that the population of this area has increased from approximately 605,000 in 1900 to 910,000 in 1930 and then to 1,280,000 in 1960. At present, approximately 60% of this population is in Rhode Island, about 5% in Connecticut and 35% in Massachusetts. The average annual population growth for the part of the tributary area within each state was determined by a study of U. S. Bureau of the Census population statistics for the years 1900 - 1960. The following table indicates the average annual rates of growth in each state for the first 30 years, the second 30 years, and the complete 60-year period.

TABLE I

Tributary State	Rate of Growth of Population		- Percent 1900 - 1960
	Average Annual Rate of Growth 1900 - 1930	1930 - 1960	
Rhode Island	2.12	0.64	1.60
Massachusetts	1.09	2.76	2.37
Connecticut	0.03	4.15	2.08

Taking into account the portion of the population in each state, the weighted-average rate of annual growth for the tributary area for the past 60 years was determined to be 1.9%. This was less than the average rate of annual growth for the nation which was about 2.5% for the same period. According to U. S. Bureau of the Census projections, the average annual rate of growth for the United States will be slightly over 2% for the next 50 years. It seems reasonable to assume that the Providence tributary area will also increase in the future, but at a slower rate than in the past. In the computation of benefits the population of the tributary area was conservatively assumed to increase in a straight-line at an average annual rate of 1.5%.

4. Petroleum Consumption. - Based on statistics in the 1959 centennial edition of Petroleum Facts and Figures, published by the American Petroleum Institute, the United States annual per capital demand for petroleum increased from 14.2 barrels in 1949 to 19.1 in 1958. For the same period, based on the percent of population in each state, the Providence tributary area increased from 29 to 32. The demand in this area is much higher than the average for the nation, because of the denser degree of development and the high consumption of heating oils. According to Mineral Facts and Figures - 1960 edition, published by the Department of the Interior, the United States annual per capital demand is anticipated to increase from the 1958 figure of 19.1 to 26.4 by the year 1975. Another source, The Adequacy of Resources for Economic Growth in the United States. - Joint Economic Committee Study Paper No. 13-6 December 1959, indicates that the United States per capita demand will be approximately 33 by the year 2000.

5. The future demand for petroleum in the Providence tributary area due to the present denser degree of development in this section of the country, is expected to increase at a slower rate than the national average. For the purpose of this study it was conservatively assumed to increase to 40 barrels per capita by the year 2018, an increase of only 25%. Advancement in other energy fields such as atomic and solar, will probably cause this petroleum per capita demand to level off beyond this time.

6. Commerce. - The Providence Harbor receipts of petroleum and petroleum products from foreign and coastwise ports for the year 1960 was 6,258,300 short tons. Due to the projected increases in population and demand, the waterborne petroleum receipts to Providence River and Harbor are expected to reach almost 20,500,000

short tons by the year 2068. The projected receipts were calculated by increasing the tonnage of 1960 in proportion to the anticipated rate of growth in population and to the expected increase in per capita demand of the tributary area, as follows:

<u>Year</u>	<u>Population Increase Factor</u>	<u>Demand Increase Factor</u>	<u>Waterborne Petroleum Receipts</u>
1960	6,258,300		
1968	$6,258,300 \times (1 + 0.015 \times 8 \text{ yrs.})$	$\frac{32}{32}$	7,009,300
2018	$6,258,300 \times (1 + 0.015 \times 58 \text{ yrs.})$	$\frac{40}{32}$	14,628,800
2068	$6,258,300 \times (1 + 0.015 \times 108 \text{ yrs.})$	$\frac{40}{32}$	20,495,900

\* Average annual rate of growth = 1.5%

7. Vessel Traffic. - Detailed statistics for the year 1960 show that 45% of the waterborne oil receipt tonnage was in vessels which experienced tidal delay. Twenty percent of this was foreign trade and 80% was domestic. A survey of current tanker construction in the United States and World shipyards shows a definite trend to larger supertankers. Table II, based on information published by the American Bureau of Shipping, indicates statistically, this trend toward larger oil carriers. Table III indicates the age of U. S. oil tankers of 10,000 gross tons and over as of 1958.

TABLE II

Oil Tankers Under Contract, Under Construction or Launched  
1947 to December 1959

<u>DWT</u>	<u>Total</u>	<u>Vessels Launched Up to December 1959</u>		<u>Vessels incomplete Up to December 1959</u>	
		<u>No.</u>	<u>% of Total</u>	<u>No.</u>	<u>% of Total</u>
18,000 to 20,000	81	80	15.8	1	0.6
20,000 to 30,000	181	167	32.9	14	8.2
30,000 to 40,000	199	170	33.5	29	17.1
40,000 to 50,000	158	71	14.0	87	51.2
50,000 and over	<u>58</u>	<u>19</u>	<u>3.8</u>	<u>39</u>	<u>22.9</u>
	677	507	100.0	170	100.0

TABLE III

Age of U. S. Fleet  
(Compiled from Lloyds Register of Shipping)

<u>Years of Age</u>	<u>10,000 Gross Tons and Over</u>		<u>Average Gross Tons</u>
Under 5	38 Vessels	615,205 Gr.T.	16,200
5 to 10	11 Vessels	231,664 Gr.T.	16,500
10 to 15	22 Vessels	2,364,331 Gr.T.	10,600
15 to 20	33 Vessels	354,511 Gr.T.	10,700

It is expected that a large number of tankers will be replaced in the next 5 to 10 years, very probably by vessels of from 26,800 to 50,000 dwt carrying capacity, having mean loaded salt water drafts up to about 38 feet. The trend toward construction of larger oil tankers is much more pronounced in the World tank fleet, where vessels over 100,000 dwt are already in operation. Oil companies and American Merchant Marine Institute representatives have stated that larger ships would be put into service in Providence River and Harbor if the channel were deepened.

8. Table IV shows the increase in larger vessel traffic at Providence Harbor in recent years, especially in the sizes that experience tidal delay. By 1968 it is conservatively estimated that 50% of the oil receipt tonnage will be in ships which experience tidal delay. This proportion is expected to increase to 60% by the year 2018 and 70% by 2068.

TABLE IV

Providence Harbor Tanker Traffic - Incoming Vessel Trips

<u>Draft</u>	<u>1955</u>	<u>1956</u>	<u>1957</u>	<u>1958</u>	<u>1959</u>	<u>1960</u>
28	33	54	14	16	22	16
30	74	78	54	70	23	28
31	150	161	160	122	103	101
32	32	40	52	48	72	56
33	4	3	4	6	14	12
34	14	16	24	40	49	55
35					24	23
<u>Over 35</u>	<u>—</u>	<u>—</u>	<u>—</u>	<u>—</u>	<u>3</u>	<u>2</u>
Total (Deep-draft)	307	352	308	302	310	293

9. As the percent of the world oil reserves located in the United States is decreasing and is expected to decline further in future years due to the more rapid discovery of oil elsewhere in the world, and the depletion of the American reserves, the amount of foreign imports is expected to increase. Total imports of foreign oil had risen from 810,500 short tons (14% of total ocean-borne petroleum receipts) in 1950 to 1,362,500 short tons in 1958 (22.5% of total ocean-borne receipts). In 1959 when the Federal Government imposed a quota on the import of foreign oil, these foreign imports fell off to 1,242,700 tons in 1959 (19.5%), 1,054,000 in 1960 (16.9%) and to 922,000 tons in 1961 (14.7%). In 1960, although foreign oil imports were only 16.9% of the total ocean-borne oil receipts, they were 20% of the portion of the oil receipts carried in large vessels. This percentage is anticipated to increase to 40% by 2018 and 60% by 2068, due to several factors. First, it is expected that gradual relaxation of the Government quota on foreign residual will take place in the immediate future, as a result of economic, as well as national policy, pressure. Secondly, it is expected that greater portions of the foreign imports will be in the form of refined products. As the most economical location of refineries is at the source (near the oil fields), it would appear that as the consumption in foreign markets increases, there will be a need for more refineries at foreign oil fields. It would also seem--after the year 2000--as U. S. reserves are less able to meet the entire U. S. demand, that inland sections of this country will be supplied by Gulf and Southwest Coast fields, and that coastal sections, especially the North Atlantic, would be more economically supplied by tankers from foreign sources. Finally it does not appear economical in the future for foreign crude to be imported to Gulf or New Jersey refineries and then rehandled and redistributed to New England ports. Table V shows the division of projected oil receipts, by percent and by tonnage, which was used in deriving benefits over the life of the project.

TABLE V

Year	Total Ocean-borne Petroleum Receipts	Projected Petroleum Receipts					
		% in Large Vessels	% Foreign in Large Vessels	% Domestic in Large Vessels	Tonnage in Large Vessels	Tonnage in Large Foreign	Tonnage in Large Domestic
1960	6,258,300	45	20	80	2,816,200	563,200	2,253,000
1968	7,009,300	50	20	80	3,504,600	700,900	2,803,700
2018	14,628,800	60	40	60	8,777,300	3,510,900	5,266,400
2068	20,495,900	70	60	40	14,347,100	8,608,300	5,738,800



10. According to statistics published by the Atlantic Regional Statistical Office of the Corps of Engineers, 45% of the 1959 receipts to Providence Harbor was carried in vessels which experienced tidal delay. These statistics showed the tonnage carried by each draft of vessel, but to simplify computations the drafts were combined into general vessel classes which approximate the drafts listed in the statistics. The same general vessel categories have been assumed to remain unchanged until 1968 unless the channel is deepened. If the channel is deepened, local shipping companies and the American Merchant Marine Institute have stated that deeper-draft vessels would be used. It is felt, however, that although larger tankers would be added, the majority of the 1968 deep-draft commerce would still be carried in tankers already in use. Table VI shows the anticipated division of large vessel classes which was used in the computation of benefits.

TABLE VI  
Future Tanker Sizes

<u>Year</u>	<u>35' Channel</u>	<u>38' Channel</u>	<u>40' Channel</u>	<u>42' Channel</u>
1968	1/3 - 19,000 dwt 1/3 - 25,000 1/3 - 32,000	1/4 - 19,000 dwt 1/4 - 25,000 1/4 - 32,000 1/4 - 40,000	1/4 - 19,000 dwt 1/4 - 25,000 1/4 - 32,000 1/4 - 46,000	1/4 - 19,000 dwt 1/4 - 25,000 1/4 - 32,000 1/4 - 53,000
2018	1/2 - 29,000 1/2 - 32,000	1/2 - 32,000 1/2 - 46,000	1/2 - 35,000 1/2 - 53,000	1/2 - 40,000 1/2 - 53,000
2068	-----Same Vessel Classes as in the Year 2018 -----			

11. Benefits. - Benefits derived from deep-draft channel improvements are evaluated by calculation of the savings in cost of transportation of petroleum commerce which would result from use of larger tankers and the reduction in tidal delay to tankers already in use. Detailed studies were made to determine the savings in transportation cost for each of the three channel depths.

12. Cost of Operating Tankers. - Estimated hourly operating costs, dead weight tonnage and average operating speeds of several sizes of supertankers were derived from published data. Table VII presents principal characteristics of representative types of tankers in both the United States and World fleets.

TABLE VII

Characteristics of Ocean-Going Tankers

B-7	Dead	Length	Beam	Draft	Design	Operating Costs (Dollars per hour)				Fuel/Day
	Weight					Speed	U. S. Flag		Foreign Flag	
	(Long Tons)	(Feet)	(Knots)	At Sea	In Port		At Sea	In Port		
	19,000	550	71	30'-7"	16	201	180	125	105	51
	25,000	577	79	33'-6"	16	217	196	135	115	53
	29,000	627	83	33'-2"	17	247	217	159	129	71
	32,000	654	86	34'-2"	17	260	229	168	138	75
	35,000	667	90	34'-6"	17	274	243	176	146	76
	40,000	715	93	36'-7"	17	305	266	198	160	89
	46,000	737	103	38'-0"	17	317	277	207	168	92
	50,000	733	102	38'-9"	17	334	291	219	177	98
	53,000	786	102	39'-3"	17	357	313	234	190	102
	60,000	810	104	41'-8"	17	382	338	249	205	102

13. Cost Per Ton. - The data in Table VII were used in computing the cost per ton for delivery of petroleum by tankers on round trips from both South American and Gulf ports to Providence using the existing 35-foot channel and also using the considered 38, 40 and 42-foot channels. It is assumed that all domestic traffic is in domestic vessels and all foreign commerce in foreign flag vessels. The following is a typical computation for a domestic commerce vessel.

Capacity - 35,000 dwt.                      Fuel = 76 Long tons/day

Speed - 17 knots                      Draft = 34'-6"

Average distance - Gulf port to Providence

Harbor = 2,100 nautical miles

Depth of channel = 38'

17 x 24 = 408 nautical miles per day

2,100/408 = 5.15 days, one way

5.15 x 2 = 10.30 days, rd. trip at sea

Fuel = 76 x 10.30 = 783

Add 5 days fuel = 380

Add stores, water, etc. - 250  
1,413 Long tons

35,000 - 1,413 = 33,587 Long tons net cargo

33,587 x 1.12 = 37,617 Short tons net cargo

Cost at sea = 10.30 x \$274 x 24 = \$67,733

Cost in port = 243 x 24 = 5,832

Tide delay (2½ hrs.) = 274 x 2.5 = 685

Round trip plus one day in port = \$74,250

Delivery cost \$74,250/37,617 = \$1.98/short ton

14. A summary of delivery costs per ton of petroleum from the Gulf ports for both the existing and considered channels is shown on Table VIII. Table IX shows similar information for petroleum from ports in South America.

TABLE VIII

Cost Per Ton of Domestic Shipping

Gulf Ports to Providence (2,100 Nautical Miles)

<u>Vessel Class</u> <u>(Long Tons)</u>	<u>35'</u> <u>Channel</u>	<u>38'</u> <u>Channel</u>	<u>40'</u> <u>Channel</u>	<u>42'</u> <u>Channel</u>
19,000	\$2.89	\$2.88	\$2.88	\$2.88
25,000	2.32	2.30	2.30	2.30
29,000	2.17	2.14	2.14	2.14
32,000	2.09	2.05	2.04	2.04
35,000	2.06 *	1.98	1.96	1.96
40,000	-	1.93	1.91	1.90
46,000	-	1.81 *	1.74	1.72
50,000	-	1.79 *	1.69	1.67
53,000	-	-	1.71	1.69
60,000	-	-	1.75 *	1.63 *

\* Vessels not fully loaded.

TABLE IX

Cost Per Ton of Foreign Shipping

South America to Providence (2,000 Nautical Miles)

<u>Vessel Class</u> <u>(Long Tons)</u>	<u>35'</u> <u>Channel</u>	<u>38'</u> <u>Channel</u>	<u>40'</u> <u>Channel</u>	<u>42'</u> <u>Channel</u>
19,000	\$1.68	\$1.68	\$1.68	\$1.68
25,000	1.38	1.36	1.36	1.36
29,000	1.33	1.31	1.31	1.31
32,000	1.28	1.26	1.25	1.25
35,000	1.26 *	1.20	1.19	1.19
40,000	-	1.19	1.18	1.17
46,000	-	1.12 *	1.08	1.07
50,000	-	1.12 *	1.05	1.04
53,000	-	-	1.06	1.05
60,000	-	-	1.08 *	1.01 *

\* Vessels not fully loaded.

15. Total Costs. - The total petroleum delivery costs in 1968, 2018 and 2068 were derived by computing the costs of transporting the projected oil tonnages shown in Table V, in the projected large vessel classes shown in Table VI. These costs are shown on Table X for the existing 35-foot channel, and for the considered 38, 40, and 42-foot channels.

16. Savings in Delivery Costs. - The possibility of operating larger tankers in the three channels under study would mean a considerable savings in petroleum transportation costs over delivery costs using the existing 35-foot channel. The three alternate channels under study are listed below with the estimated savings in petroleum transportation costs.

Petroleum Delivery Cost - Savings Over 35' Channel

<u>Year</u>	<u>Domestic</u>	<u>Foreign</u>	<u>Total Savings *</u>
<u>38' Channel</u>			
1968	\$ 402,400	\$ 52,000	\$ 253,200
2018	1,053,200	403,800	930,400
2068	1,147,700	990,000	1,563,800
<u>40' Channel</u>			
1968	542,500	73,000	344,200
2018	1,553,500	632,000	1,408,800
2068	1,692,900	1,549,600	2,396,000
<u>42' Channel</u>			
1968	577,600	78,200	367,000
2018	1,764,200	684,600	1,566,700
2068	1,922,400	1,678,700	2,639,900

\* Savings on Domestic Traffic credited 1/2 to shipping port.

TABLE X

Year	Total Tonnage	Transportation Costs - 35' Channel				Transportation Costs - 38' Channel				Transportation Costs - 40' Channel				Transportation Costs - 42' Channel			
		Vessel Class	Tonnage By Vessel	Cost /Ton	Total Costs	Vessel Class	Tonnage By Vessel	Cost /Ton	Total Costs	Vessel Class	Tonnage By Vessel	Cost /Ton	Total Costs	Vessel Class	Tonnage By Vessel	Cost /Ton	Total Costs
DOMESTIC COMMERCE																	
1968	2,803,700	19,000	934,600	\$2.89	\$2,701,000	19,000	700,900	\$2.88	\$2,018,600	19,000	700,900	\$2.88	\$2,018,600	19,000	700,900	\$2.88	\$2,018,600
		25,000	934,600	2.32	2,168,300	25,000	700,900	2.30	1,612,100	25,000	700,900	2.30	1,612,100	25,000	700,900	2.30	1,612,100
		32,000	934,600	2.09	1,953,300	32,000	700,900	2.05	1,436,800	32,000	700,900	2.04	1,429,800	32,000	700,900	2.04	1,429,800
						40,000	700,900	1.93	1,352,700	46,000	700,900	1.74	1,219,600	53,000	700,900	1.69	1,184,500
				6,822,600				6,420,200				6,280,100				6,245,000	
2018	5,266,400	29,000	2,633,200	2.17	5,714,000	32,000	2,633,200	2.05	5,398,100	35,000	2,633,200	1.96	5,161,100	40,000	2,633,200	1.90	5,003,100
		32,000	2,633,200	2.09	5,503,400	46,000	2,633,200	1.81	4,766,100	53,000	2,633,200	1.71	4,502,800	53,000	2,633,200	1.69	4,450,100
					11,217,400				10,164,200				9,663,900				9,453,200
2068	5,738,800	29,000	2,869,400	2.17	6,226,600	32,000	2,869,400	2.05	5,882,300	35,000	2,869,400	1.96	5,624,000	40,000	2,869,400	1.90	5,451,900
		32,000	2,869,400	2.09	5,997,000	46,000	2,869,400	1.81	5,193,600	53,000	2,869,400	1.71	4,906,700	53,000	2,869,400	1.69	4,849,300
					12,223,600				11,075,900				10,530,700				10,301,200
FOREIGN COMMERCE																	
1968	700,900	19,000	233,600	\$1.68	\$ 392,400	19,000	175,200	\$1.68	\$ 294,300	19,000	175,200	\$1.68	\$ 294,300	19,000	175,200	\$1.68	\$ 294,300
		25,000	233,600	1.38	322,400	25,000	175,200	1.36	238,300	25,000	175,200	1.36	238,300	25,000	175,200	1.36	238,300
		32,000	233,600	1.28	299,000	32,000	175,200	1.26	220,700	32,000	175,200	1.25	219,000	32,000	175,200	1.25	219,000
						40,000	175,200	1.19	208,500	46,000	175,200	1.08	189,200	53,000	175,200	1.05	184,000
				1,013,800				961,800				940,800				935,600	
2018	3,510,900	29,000	1,755,400	1.33	2,334,700	32,000	1,755,400	1.26	2,211,800	35,000	1,755,400	1.19	2,088,900	40,000	1,755,400	1.17	2,053,800
		32,000	1,755,400	1.28	2,246,900	46,000	1,755,400	*1.12	1,966,000	53,000	1,755,400	1.06	1,860,700	53,000	1,755,400	1.05	1,843,200
					4,581,600				4,177,800				3,949,600				3,897,000
2068	8,608,300	29,000	4,304,200	1.33	5,724,600	32,000	4,304,200	1.26	5,423,300	35,000	4,304,200	1.19	5,122,000	40,000	4,304,200	1.17	5,035,900
		32,000	4,304,200	1.28	5,509,400	46,000	4,304,200	*1.12	4,820,700	53,000	4,304,200	1.06	4,562,400	53,000	4,304,200	1.05	4,519,400
					11,234,000				10,244,000				9,684,400				9,555,300

\*Vessel Not Fully Loaded

17. Savings anticipated in future years were reduced to equivalent annual benefits for both a 50 year life-of-project and a 100 year life-of-project. As growth was projected on a straight line basis, the savings were reduced to present worth at 2.875% and then converted to annual equivalent benefits by the following factors:

Average Annual Equivalent Factor - 50 year straight line growth	=	0.39572
Present Worth Factor - 50 year uniform series	=	26.352
Present Worth Factor - 50 year single payment	=	0.2424
Capital Recovery Factor - 100 year	=	0.03054

18. A summary of the annual benefits for the main channel based on the above criteria, is listed below:

	<u>50 Year Life</u>	<u>100 Year Life</u>
38' Channel	\$521,200	\$ 649,900
40' Channel	765,500	967,100
42' Channel	841,800	1,066,000

19. India Pt. Channel. The Tidewater Terminal and Stevedoring Company and its associate Company, General Scrap Iron, Inc., own and operate a terminal at India St., Providence, on the India Pt. Channel. This dock, used for the export of scrap metals, is located at the northeastern corner of Providence Harbor, near the mouth of the Seekonk River, between Fox Pt. and India Pt. There are about 650 feet of waterfront with a berth depth of 25 feet, and open storage area of about  $2\frac{1}{2}$  acres. There is a controlling depth of 22 feet at mean low water in the unimproved approaches to the berth. The India St. yard is connected to adequate highway and rail facilities. In addition to this yard, the Company owns another yard on Dexter Rd., East Providence, about 1 mile away on the left bank of the Seekonk River. In anticipation of future export increases General Scrap Iron, Inc. has formulated plans for developing an additional terminal on the waterfront adjacent to their wharf.

20. Scrap metal is received at the India St. yard by truck from either the Dexter St. yard or other yards within a 35-mile radius of Providence. The scrap is weighed and placed in piles of 1,000 gross tons prior to loading on ship. Vessels at India St. terminal are loaded by two or three cranes having a total capacity of 900 long tons per day.

21. Existing Commerce and Vessel Traffic. Exports of scrap iron from Providence River and Harbor have more than quadrupled since 1953. In recent years almost all the exports of this material have been shipped from the India St. dock. Tonnages from this terminal in recent years have fluctuated from 61,000 long tons in 1959 to a high of 114,000 long tons in 1961. The average annual shipment for the past four years has been approximately 85,000 long tons.

22. In this harbor most of the vessels presently engaged in scrap iron commerce are foreign ships in the Liberty and "Jumboized" Liberty classes. The "Jumboized" Liberty is a renovated Liberty ship which has been elongated by the addition of a new, longer midsection. Both classes have similar drafts, about 27'-6". The Liberty vessels hold about 9,300 long tons of scrap, and the larger vessels, about 11,300 long tons.

23. Prior to 1959, all cargo from the India St. terminal was exported in partially-loaded vessels, the remainder of the load being made up at other ports. This practice was not economical and resulted in higher transportation costs. In order to reduce these costs efforts have been made to export fully-loaded vessels. Due to the shallow depth in the channel in front of the terminal, the vessels must be partially loaded at the India St. dock, and then moved to another wharf in the main harbor to complete loading. This practice, while more economical than the former, still does not allow for the most economical method of shipping.

24. The following table shows the total vessel trips and export tonnages for the years 1959 through 1962, with the corresponding fully-loaded vessel trips and tonnages.

<u>Year</u>	<u>Total Trips</u>	<u>Total Tonnage</u>	<u>No. Fully-Loaded Vessel Trips</u>	<u>Tonnage Fully-Loaded Vessels</u>	<u>% Total Annual Tonnage Carried in Fully-Loaded Vessels</u>
1959	10	61,000	4	36,500	60%
1960	13	86,500	6	54,300	63
1961	14	114,000	9	86,300	70
1962	8	84,500	7	73,500	87



25. Difficulties Attending Navigation. The controlling depth in the harbor approach to the India St. dock is 22 feet. This means that the ships can be loaded only partially at this dock, and then must be shifted to Field Pt. before being completely filled. Liberty ships can be loaded with only 6,500 long tons, and Jumboized Liberty ships with only 9,000 long tons. Depending on the particular ship, this necessitates loading, on an average, an additional 2,800 long tons at Field Pt. to fill a Liberty ship, and 2,300 long tons to fill the Jumboized Liberty. Deepening the channel would make it possible to fully load all vessels at the India St. dock, thereby reducing vessel and cargo loading and handling costs.

26. Projected Commerce. Despite recent introductions of alternate metals in the fabrication of products, formerly the exclusive prerogative of steel, the export trade in iron scrap has continued to increase. It is considered that the increase is due primarily to the lower price of scrap iron as compared with iron ore. The requested improvement would substantially reduce the cost per ton of exported scrap, making it more favorable to the world market, particularly to areas such as Japan, where both iron scrap and iron ore must be imported. Due to the present industrial growth rate in Japan, and that anticipated in similar areas of the world, it is considered that exports in scrap iron will continue to increase. Based on past records of this commerce, with recognition made of large annual fluctuations, it is estimated conservatively that an average of 15,000 tons will be added to present commerce in the harbor.

27. Benefits. Benefits are expected to accrue to the considered improvement due to the elimination of additional vessel charges and the reduction in loading costs caused by the present practice of loading at two terminals. The shallow depths in the channel approaching the India St. dock limit the capacity to which a vessel can be loaded. At the present controlling channel depth Liberty ships can be loaded to only 6,500 long tons, and Jumboized Liberty ships to only 9,000 long tons. The additional 2,800 tons required to fill the former, and the 2,300 tons required for the latter, must be loaded at the Municipal Wharf at Field Pt. Extra costs are incurred in shifting vessels to Field Pt., in dockage and wharfage fees at Municipal Wharf, in trucking cargo between terminals, and in the reduced loading efficiency at Municipal Wharf.

28. In the past, most of the scrap iron has been exported in Liberty ships, which were built in World War II. In recent years there has been a gradual increase in the use of Jumboized Liberty

ships, which are more economical. Also, the Jumboized Liberty ship is more representative of the class of vessel which will be used in the future exports of scrap iron. For these reasons, this vessel was conservatively assumed to carry all future commerce.

29. Of the projected annual commerce of 100,000 long tons, it is conservatively assumed that 10,000 tons would still be carried in partially loaded vessels even after the channel is deepened. This is approximately the same percentage as in 1962. It is assumed that the remaining 90,000 tons will be exported in 8 vessel trips by Jumboized Liberty ships.

30. The cost of shifting one vessel from the India St. dock to Field Pt., including the charges for two tugboats and running and dropping of lines is about \$450. For 8 vessels per year this amounts to an annual benefit of \$3,600.

31. Dockage and Wharfage fees at Municipal Wharf would amount to an estimated 15¢ per ton over that required for loading cargo at the India St. dock. As each shifted vessel must load an average of 2,300 tons, this would amount to an annual benefit of \$2,800.

32. The cost of shifting cargo from the India St. scrap yard to the dock at Field Pt. has been conservatively estimated at \$1/ton. About half of the 2,300 gross tons required per vessel at Field Pt. would be brought directly from yards other than the one at India St. This would involve only slight, if any, additional charge. However, due to the nature of scrap iron and the manner in which the vessel must be loaded, the final cargo loaded must be selected with certain control on the quality, weight, and void ratio. This selected scrap iron is stored at the India St. yard and generally comprises over half of the tonnage loaded at Field Pt. It is estimated that the additional charge for trucking this scrap from India St. to Field Pt. would amount to \$9,200 per year.

33. At the India St. terminal, vessels are loaded from dockside by crawler-type cranes. The loading rate at present is about 900 long tons per day. This is expected to increase to about 1,200 per day, due to the planned purchase of a new, larger crane. When vessels are loaded at Field Pt. these cranes are not available, so the scrap is loaded from the trucks by use of the vessel cargo hoists. This procedure is considerably slower, having a maximum loading rate of about 600 long tons per day. This reduced loading rate, coupled with the time required to shift the vessels between terminals causes undue delays resulting in demurrage charges to the shipper. It is estimated that the demurrage charges for the

projected commerce, at an average of \$900 per vessel loaded at Field Pt., would result in an annual cost of \$7,200.

34. The total annual benefits which are expected to accrue to the considered improvement as a result of the elimination of shifting and loading at a second terminal are \$22,800. A summary of the projected annual benefits follows.

Shifting vessels from India St. to Field Pt.	\$ 3,600
Dockage and Wharfage charges at Field Pt.	2,800
Trucking charges from India St. to Field Pt.	9,200
Demurrage charges	<u>7,200</u>
TOTAL ANNUAL BENEFITS	\$22,800

35. There is some question as to the advisability of assuming that these benefits will continue for a project life of 50 or 100 years; however, it is noted that the annual charges of the improvement are such that the project would be justified, with a B/C ratio of 1.2, if these benefits continued for only 20 years. There is no evidence that these benefits will not continue for 50 or 100 years.

36. Total Annual Benefits. The total annual benefits for the combined recommended projects, the 40-foot main channel and the 30-foot India Pt. channel, are as follows:

	<u>40-Foot Main Channel</u>	<u>30-Foot India Pt. Channel</u>	<u>Total Annual Benefits</u>
50 Year Life	\$765,500	\$22,800	\$788,300
100 Year Life	\$967,100	22,800	989,900

APPENDIX C  
UNITED STATES  
DEPARTMENT OF THE INTERIOR  
FISH AND WILDLIFE SERVICE  
59 Temple Place  
Boston 11, Massachusetts

October 3, 1962

Division Engineer  
New England Division  
U. S. Army Corps of Engineers  
424 Trapelo Road  
Waltham 54, Massachusetts

Dear Sir:

This letter is our conservation and development report on your navigation study of Providence River and Harbor, Rhode Island, as outlined in Mr. Leslie's letter of August 16, 1962, and accompanying sketch. This report was prepared under authority of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.), in cooperation with the Rhode Island Division of Fish and Game, and has the concurrence of that agency as indicated by their letter dated September 19, 1962.

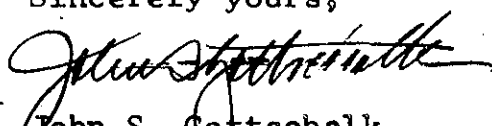
The plan of improvement under consideration consists of deepening the existing project from 35 feet to 40 feet and extending it southerly to a point just below the Prudence Island Light. All sharp bends in the channel are to be dredged to a minimum 5,000-foot radius to accommodate two-lane vessel traffic. The dredged material, approximately 9,000,000 cubic yards, will be bucket-dredged and scowed to sea for deposit on an approved dumping ground  $4\frac{1}{2}$  miles south of Brenton Reef Light Ship.

Our studies indicate that the project works as proposed would have no significant effect upon fish and wildlife habitat or resources. It would not be practical to utilize spoil materials from this project for enhancement of fish and wildlife habitat. Should there be any change in your plans for deposition of spoil we would appreciate being advised so that we can prepare another report.

Sincerely yours,



John T. Gharrett  
Regional Director  
Bureau of Commercial  
Fisheries



John S. Gottschalk  
Regional Director  
Bureau of Sport Fisheries  
and Wildlife

## APPENDIX D

### LONG DISTANCE PIPELINES

1. General. - This appendix considers the effect of long distance pipelines on use of large tankers for delivery of petroleum products to New England ports. Construction of the Colonial Pipeline from Texas to New York, with extension to New England being mentioned as a possibility, raises the question of the future volume of deep-draft tanker traffic.

2. The available data on pipelines has been considered. The following report and published articles are of interest:

a. "Estimate of the Impact of Colonial Pipeline on Activity of the United States Tanker Fleet", Report by Ernst & Ernst, 1701 K Street N. W., Washington 6, D. C. for Shipbuilders Council of America, 1730 K Street, N.W. Washington 6, D. C. 20 June 1962.

b. "Old pipeline proposals may be revived", The Oil and Gas Journal, 13 November 1961, pp. 129 and 130.

c. "Silent Pipelines in Freight Role" (Associated Press) The Christian Science Monitor, 19 November 1962.

d. "Products lines to New England being studied", The Oil and Gas Journal, 20 November 1961, p. 145.

e. "World's biggest products line planned", The Oil and Gas Journal, 5 March 1962, pp. 59-61.

f. "Pipeline to Stretch from Texas to N. J.", The Christian Science Monitor, 13 March 1962.

g. "Big pipe to East may short-cut tankers", Business Week, 17 March 1962, pp. 29-30.

h. "Who Laughs Last?", Maritime Reporter, 15 April 1962.

i. "Watching 2,600 miles of pipeline grow", Fortune, February 1963, pp. 100, 109.

3. Transportation Costs. Savings in shipment costs would be the major reason for changing from use of tankers to a pipeline. The possibility of such savings on deliveries to New England ports are considered below.

4. Published estimates of pipeline tariffs for delivery of petroleum products range from \$0.25/bbl at Atlanta, Georgia to \$0.35/bbl at New York. On a tonnage basis the New York delivery price would be about \$2.50 per ton. Similar per ton per tanker delivery costs to Providence are \$3.15 in T-2's (16,700 dwt), \$2.04 in 32,000 dwt tankers, and \$1.74 in 46,000 dwt tankers. Thus, it is apparent that delivery to New England ports is more economical in the large size tankers than piping to New York. Pipeline transportation to New York with rehandling and transportation by tanker to New England ports is out of the question in an economic sense. Extension of the pipeline to Boston would add a further increase in pipeline delivery costs. A preliminary estimate of these added costs is about \$0.28 per ton.

5. It should be noted also that the delivery cost per ton to New York via the pipeline is estimated also and could be much higher. At the present time a pipeline company, Plantation Pipeline Company, operates a facility running from Louisiana to North Carolina. Its present rates are \$0.40 per barrel or \$2.90/ton. Extension of this rate would indicate a delivery cost of \$4.40/ton to New York and \$4.68 to Boston.

6. The previously described economics pertain to current movements of the products. Future delivery costs of the pipeline are expected to decrease as the pipeline is amortized and debt is reduced. Conversely, tanker delivery costs are expected to increase. The increase will result from higher construction costs of vessels, with consequent higher fixed costs. The report by Ernst & Ernst estimates that such tanker costs would increase by about 15 percent and pipeline costs to decrease by about \$0.05/bbl. This would indicate future costs of about \$2.13 per ton for the pipeline commerce at New York and \$2.45 per ton to Providence and Boston. For future tanker costs the averages would be \$2.02 for 46,000 dwt, \$2.30 for 32,000 dwt, and \$3.62 for T-2's.

7. To date, plans for extending the pipeline into Boston are strictly in the talking stage. No definite construction plans have been announced. Should the pipeline be extended to Boston, it is considered that higher unit costs of construction would be involved. This consideration is based on the more populous nature of the area,

with relatively high costs of land acquisition and proportionally higher local taxes. In this event, tariffs for the delivery from the present terminus in New York to Boston would be relatively higher on a per-mile basis.

8. The Ernst and Ernst report also finds that delivery to North Atlantic ports at present rates is more economical by tanker. However, the report does bring out one salient fact, which appears to justify participation of the major oil companies in construction of the pipeline. In locations where oil deliveries are made to deep-draft tidewater terminals and then transferred by rail, truck or barge, to secondary terminals and rehandled for delivery to the retail outlet, pipeline delivery by spur from the trunk line is much more economical. Since the route of the pipeline is quite a distance inland for a great part of its length, it appears that the major economies to be derived from its construction will be derived from this inland source. This aspect of the pipeline's economy is considered to benefit the inland areas of the Southeastern and Middle Atlantic States. Also, it is considered that tidewater deliveries to southeastern ports, normally subject to secondary transportation, will be curtailed, probably accounting for the much publicized retirement of a considerable portion of the U. S. Flag tanker fleet. The availability of these ships could cause a reduction in tanker delivery costs to New England ports.

9. In New England a large proportion of retail deliveries is made directly from large deep water terminals, without rehandling through secondary terminals. Therefore the major potential advantage of the long distance pipeline, elimination of transportation to secondary terminals, would not be as pronounced in this area. Therefore, it is considered questionable at this time whether the extension of the pipeline to Boston would be economical.

10. In summary, it is believed that at the present time the pipeline tariffs about equal T-2 costs, as computed for New England ports. In point of fact the larger tankers can deliver petroleum products to this area more economically than pipeline alone or any combination of pipeline delivery to New York, rehandling and shipping by tanker, or pipeline to New England. There may be a future decrease in delivery costs to New York and increased costs to constructing future tankers. Even with the estimated decreased cost of pipelines and increased costs of tankers, the delivery costs for the large tankers would be more economical in this area. The increased costs for tankers do not recognize any future improvement in the design, efficiency, or future speed of tankers, or the effect of pipeline competition. Any one of these factors could serve to

keep delivery costs for tankers to little more than present levels. In addition, future pipeline improvement costs would be higher than at present. Of course, no additional land takings would be necessary, which would serve to keep overall costs relatively lower. While this is true, it is believed that future pipeline extensions would involve large construction costs which would tend to keep future delivery costs at about the same relative plane comparable to future tanker delivery costs. It is believed that large tankers now in use will continue to have an economic advantage over pipelines for petroleum deliveries to New England from ports on the Gulf Coast.

11. Pipeline capability. - At present, pipeline construction could only affect refined products now shipped from Gulf Ports. (There are future possibilities of pipeline transportation from western or Canadian oil fields, which could not be carried by tankers in any case, but this probably will not become economic until southwestern oil sources are depleted). The pipeline now under construction from Texas to New York could affect only those products shipped from Gulf ports. Products involved are gasoline, kerosene, and distillate fuel oils. Initial deliveries through the pipeline will be in the order of about 600,000 barrels per day. Maximum capacity is 800,000 bbl/day and no doubt this capacity will be utilized soon after the operation is initiated. It is reported that the capacity could be increased to 1,000,000 bbl/day, with comparatively minor modifications to the pumping stations. The route is mostly inland with spur lines extending to the principal populous areas adjacent to its route.

12. New England consumption of these products is greater than the capacity of this pipeline now, and is rapidly increasing. However, as noted above, the economic advantage of the pipeline is greatest in inland areas of the Southeast and Mid-Atlantic States, where present consumption is also greater than the pipeline's capacity. It appears that construction of additional capacity and extension to New England would be necessary before there would be any effect on tanker traffic to New England.

13. The pipeline under construction is not capable of handling residual fuels, which must be kept warm for pumping, and tankers will continue to be needed for this traffic as long as residual fuels are cheaper than other fuels. Because residual fuels are the left overs from the refining process, they are priced to meet competitive fuels. It is therefore considered residual fuels will continue to be competitive, and will be used for fuel until refineries reach 100 percent efficiency, or crude supplies are depleted.



14. Tankers will also be needed to import petroleum from foreign sources. Domestic supplies are decreasing, foreign supplies are increasing, and pipelines from overseas oil sources are not yet practical. Although New England imports are presently limited by quotas, there is no question that New England fuel requirements will result in increased fuel imports.

15. Other factors. The most important factor that will affect the use of tankers or pipelines for future petroleum deliveries to New England will be the effect of Federal policies. Tax advantages to domestic oil producers for plant investment in pipelines, subsidies for oil production, and import quotas will act to increase the economic advantage of pipelines. Continued subsidies for domestic tanker construction, relaxation of import quotas to reduce New England fuel costs, trade or aid agreements with foreign oil producing countries all will act to increase the use and economic advantage of deep-draft tankers. All of these policies are under discussion now and future changes are probable. However, it is considered that policy changes are not apt to substantially reduce the use of deep-draft tankers for New England petroleum deliveries.

16. Another consideration, not readily measurable in dollars, is national defense. U. S. pipelines were constructed during World War II so that tankers could be released to deliver oil overseas. At that time there was little possibility that the pipeline might be put out of action by enemy bombing; however, if all future petroleum products to New England were carried in one single pipeline, or in several lines in a single right-of-way, it would be possible to destroy this line with one bomb or missile. It would seem preferable for national security for future methods of transportation to be kept as diversified as possible. A multi-port development system which contains such a large number of vessels as the World and U. S. tanker fleets, would be difficult, if not impossible, to eliminate completely.

PROVIDENCE RIVER AND HARBOR  
PROVIDENCE, RHODE ISLAND

INFORMATION CALLED FOR BY SENATE RESOLUTION 148,  
85TH CONGRESS, 1ST SESSION, ADOPTED 28 JANUARY 1958.

1. Navigation Problems. - Providence River is a tidal estuary extending northerly from the upper limits of Narragansett Bay about 8 miles inland to the City of Providence. The upper  $2\frac{1}{2}$  miles comprise the Main Harbor, which is that portion of the river south of Fox Pt. and India Pt. and extending generally south of Field Pt. The existing Federal project provides for a depth of 35 feet in both the Main Harbor and the 600' wide entrance channel.

2. The major difficulties attending navigation are due to the sharp bends in the main channel and the lack of sufficient depth to accommodate large tankers. The minimum radii of the existing channel bends vary from 600 feet to 4500 feet, which makes navigation of super-tankers hazardous. The 35-foot depth limits the maximum size tanker, which may safely navigate the channel to 33,000 dwt. Vessels in the 20,000 dwt to 33,000 dwt classes are subject to varying degrees of tidal delay. Only tankers in the T-2 (16,500 dwt) or smaller classes are able to navigate safely at all stages of tide. In addition, exports of scrap metals in Liberty ships from a terminal near India Pt. are hindered by inadequate depths in the approach channel.

3. Improvements Considered. - Consideration was given to deepening the main channel to 38, 40 and 42 feet, and to providing a 30 x 150-foot India Pt. channel. Consideration was given to providing the straightest channel alignment economically possible. Alternate methods of transportation such as off-shore terminals and overland pipelines were also considered.

4. Recommended Improvement. - It is recommended that the existing project be modified to provide a channel 40 feet deep and generally 600 feet wide, from the harbor proper to a point just south of Prudence Island Light and a channel 30 feet deep and 150 feet wide along the India Street waterfront. The estimated first costs, annual charges and annual benefits, based on 1962 price levels, a 100-year project life and an interest rate of  $2\frac{7}{8}$  percent are as follows:

a. Estimated First Cost of Construction

Federal	\$13,900,000 *
Non-Federal	<u>0</u>
Total Estimated First Cost of Construction	\$13,900,000

\*Excludes preauthorization study cost of \$57,000 and additional navigation aids of \$58,000.

b. Estimated Annual Charges

	<u>Federal</u>	<u>Non-Federal</u>	<u>Total</u>
Interest & Amortization	\$ 444,500	-	\$444,500
Maintenance	22,400	-	22,400
Total Estimated Annual Charges	\$ 466,900	-	\$466,900

c. Estimated Annual Benefit. - Benefits result from savings in transportation by using larger tankers, and the elimination of tidal delays to present tankers using the main channel. Benefits for the India Pt. channel are the savings from completely loading vessels at one dock. These annual benefits amount to \$989,900, and in view of the commercial nature of the navigation served, are entirely general in character.

d. Benefit-Cost Ratio = 2.1.

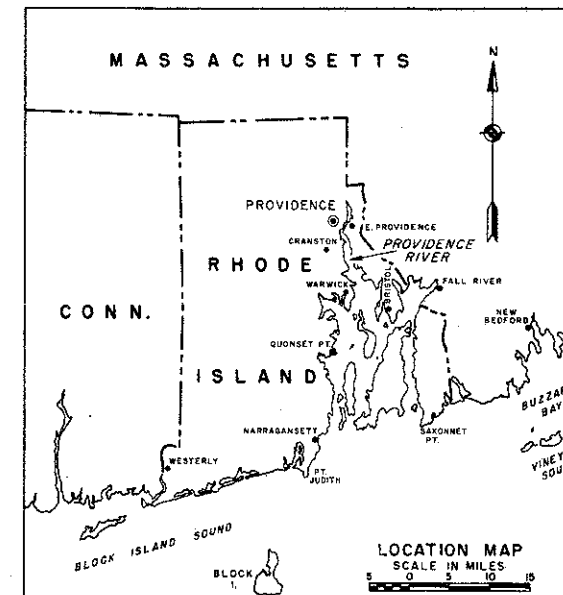
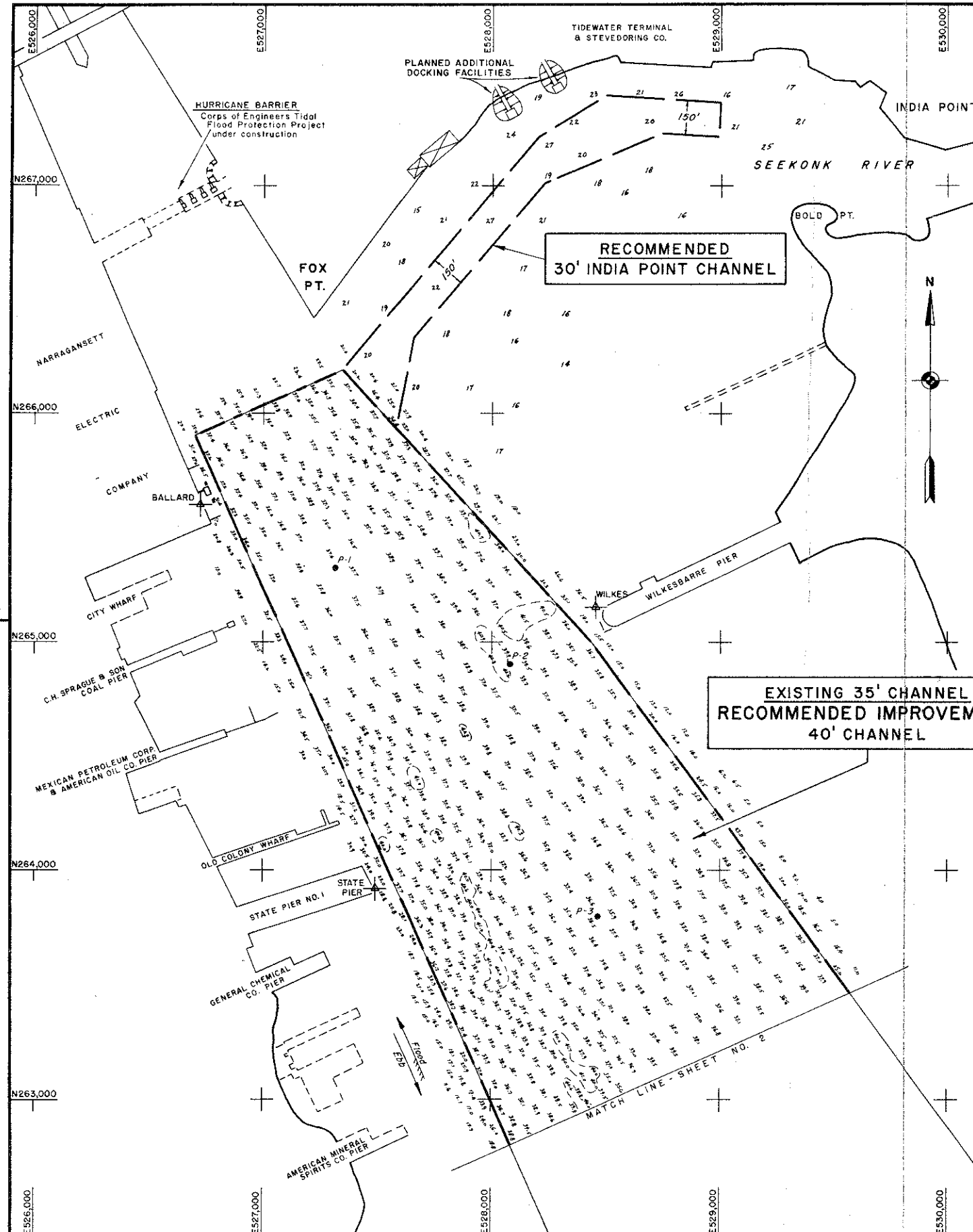
5. Local Cooperation. - The benefits to be derived from the improvement of Providence River and Harbor are general in nature and as such, require no local cash contribution towards the first cost of construction of the project; however, it is proposed and local interests shall be required to:

a. Hold and save the United States free from damages due to the construction and maintenance of the project.

b. Provide and maintain without cost to the United States depths in berthing areas commensurate with the project depth.

6. Discussion. - Local interests have approved the recommended plan of improvement and have indicated that the requirements of local cooperation will be met. The recommended improvement would provide an economically feasible means of meeting the present and prospective navigation needs of commerce in the river. Analysis on the basis of a 50-year and a 100-year life of project would result in benefit-cost ratios of 1.3 and 2.1 respectively. The project is considered justified on the basis of studies and criteria utilized in the report.

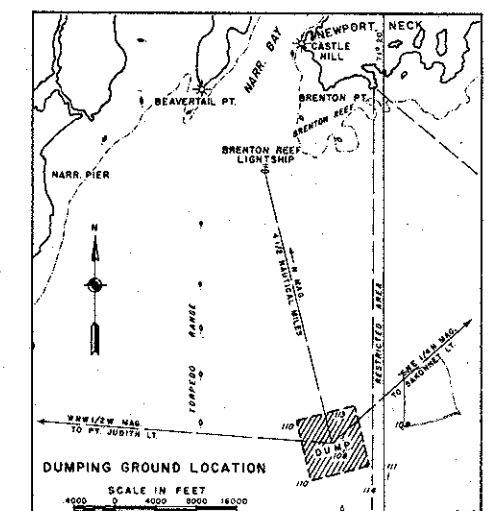
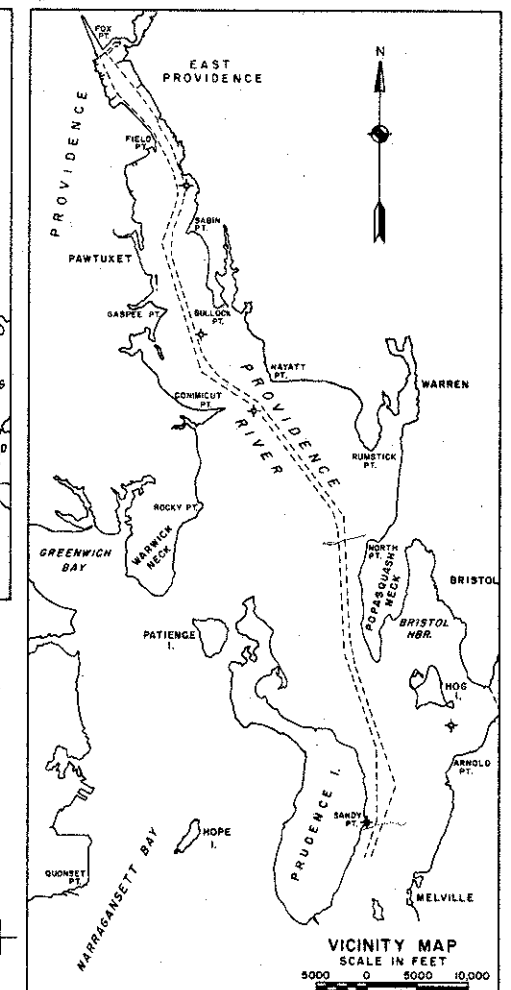




NUMBER	ELEVATION BELOW MSL		METHOD OF PROBING	
	DEPTH OF WATER	DEPTH OF PROBE	DEPTH BY HAMMER OVER BLOW COUNT	DEPTH BY HAMMER OVER BLOW COUNT
1	35.8	47.0	11.2	46.6
2	39.8	48.5	7.2	45.5
3	35.1	47.0	11.9	42.7

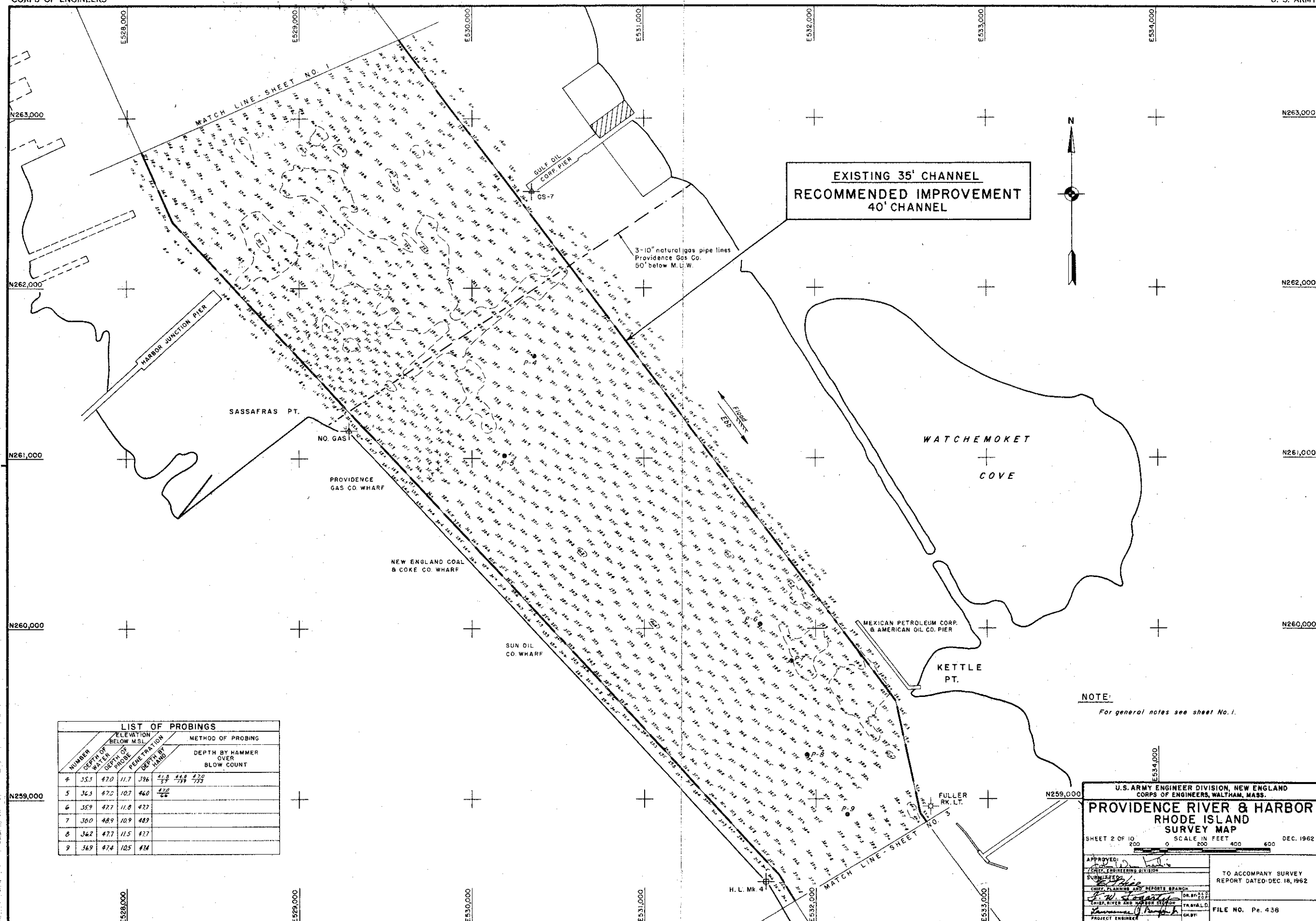
## NOTES:

Soundings and probings are in feet and tenths and are referred to the plane of Mean Low Water.  
 Probings were taken from barge "Salem" with 1 1/2" drill rod or iron pipe, forced down by two men, or driven by 140 lb. hammer lifted by winch and dropped 2 feet.  
 Probings are from survey of May, June & July 1962, by John Rock.  
 Hydrography is from surveys by H. A. Fishlock: Fox Pt. to Sabin Pt. - December 1959 & September 1960, Sabin Pt. to North Pt. - April 1959, & North Pt. to Prudence I. Lt. - March, April & May 1961.  
 Topography is from previous surveys and from U. S. G. S. charts 236 & 278.  
 Coordinates are on the State of Rhode Island Grid System.

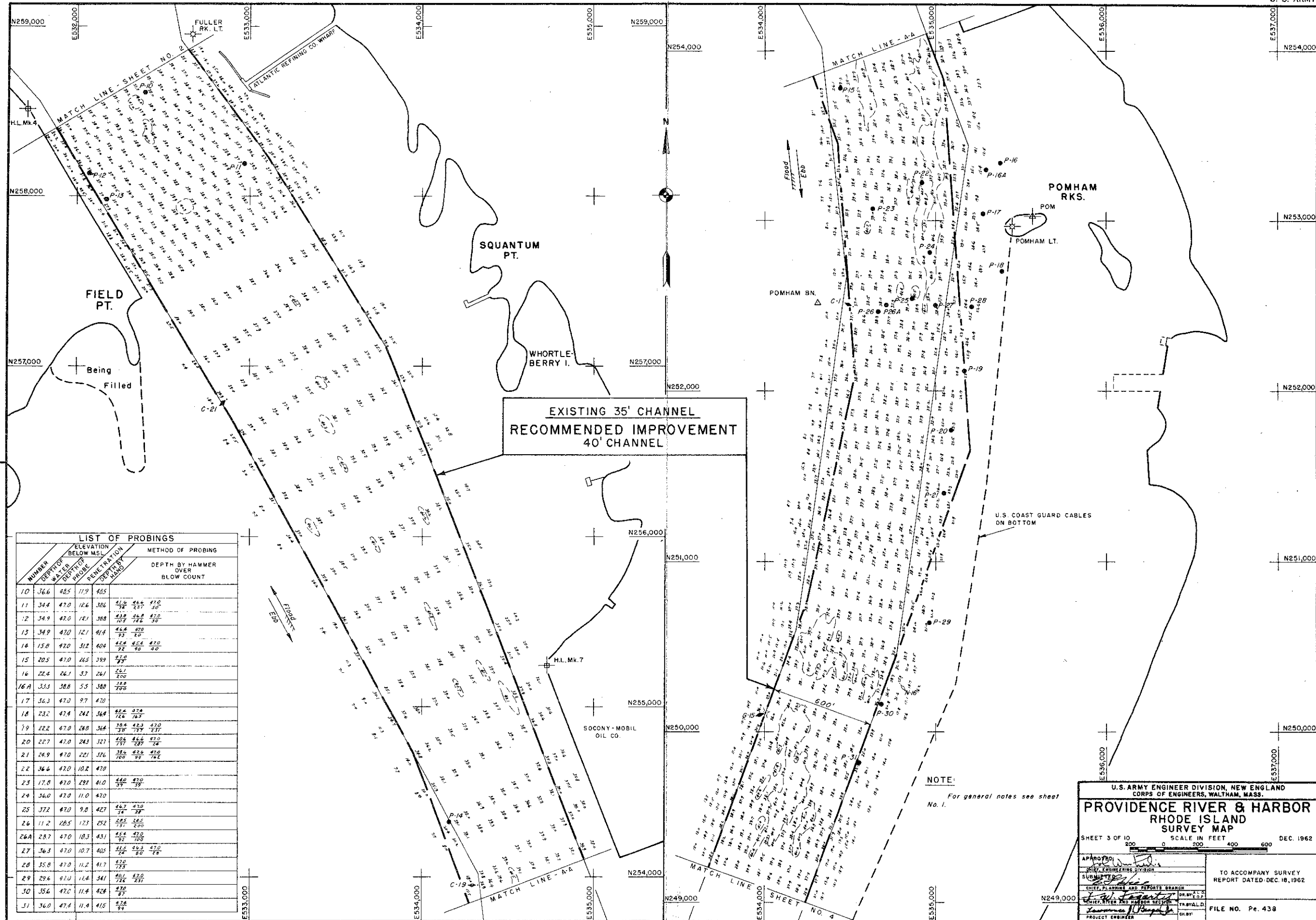


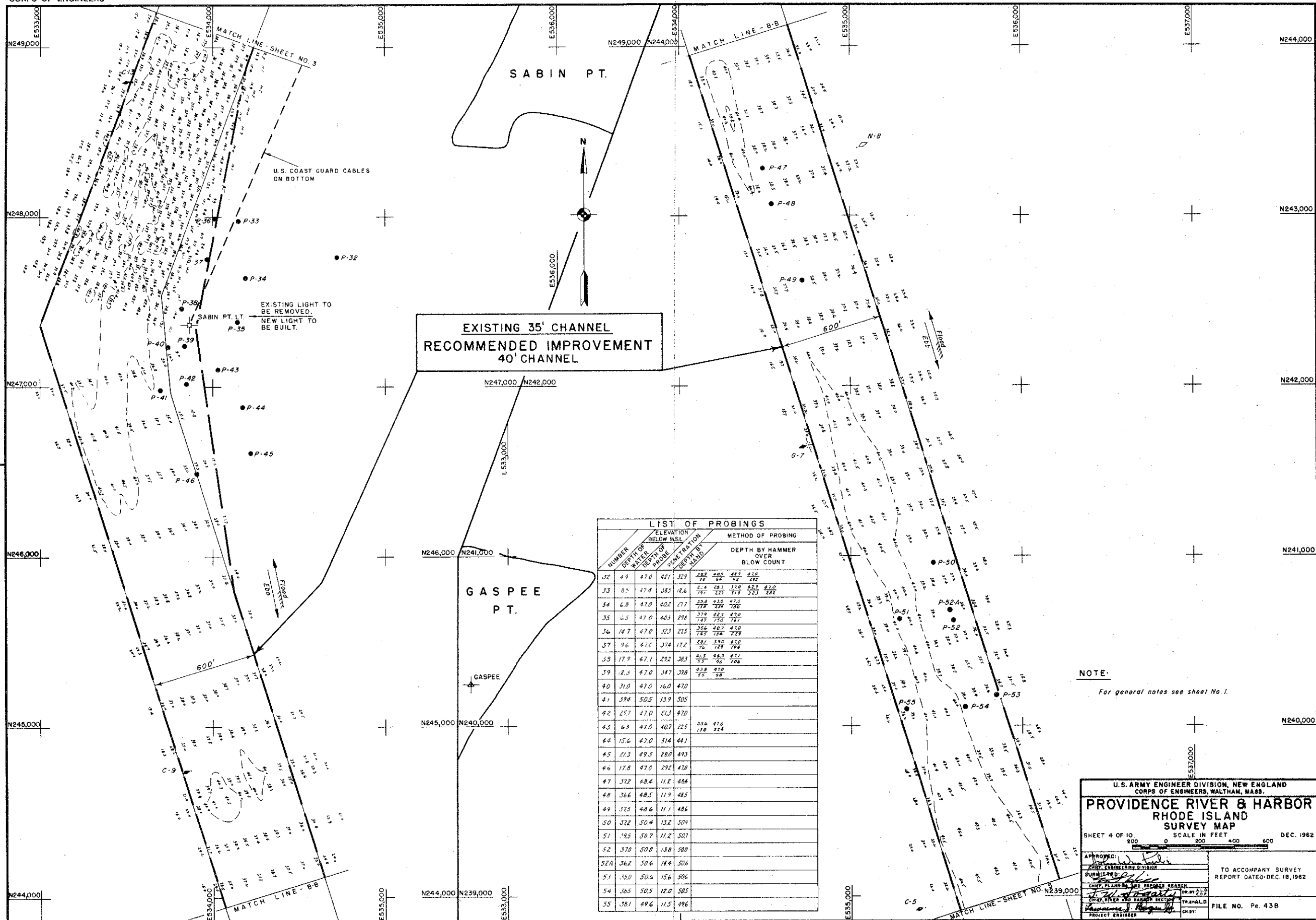
U. S. ARMY ENGINEER DIVISION, NEW ENGLAND CORPS OF ENGINEERS, WALTHAM, MASS.	
<b>PROVIDENCE RIVER &amp; HARBOR RHODE ISLAND SURVEY MAP</b>	
SHEET 1 OF 10	SCALE IN FEET 0 200 400 600
APPROVED: [Signature]	TO ACCOMPANY SURVEY REPORT DATED DEC. 18, 1962
SUBMITTED: [Signature]	FILE NO. Ps. 438
CHIEF, PLANNING AND REPORTS BRANCH	DR. BY [Signature]
CHIEF, RIVER AND HARBOR SECTION	TR. BY [Signature]
PROJECT ENGINEER	CK. BY [Signature]

REVISED FEB. 1963

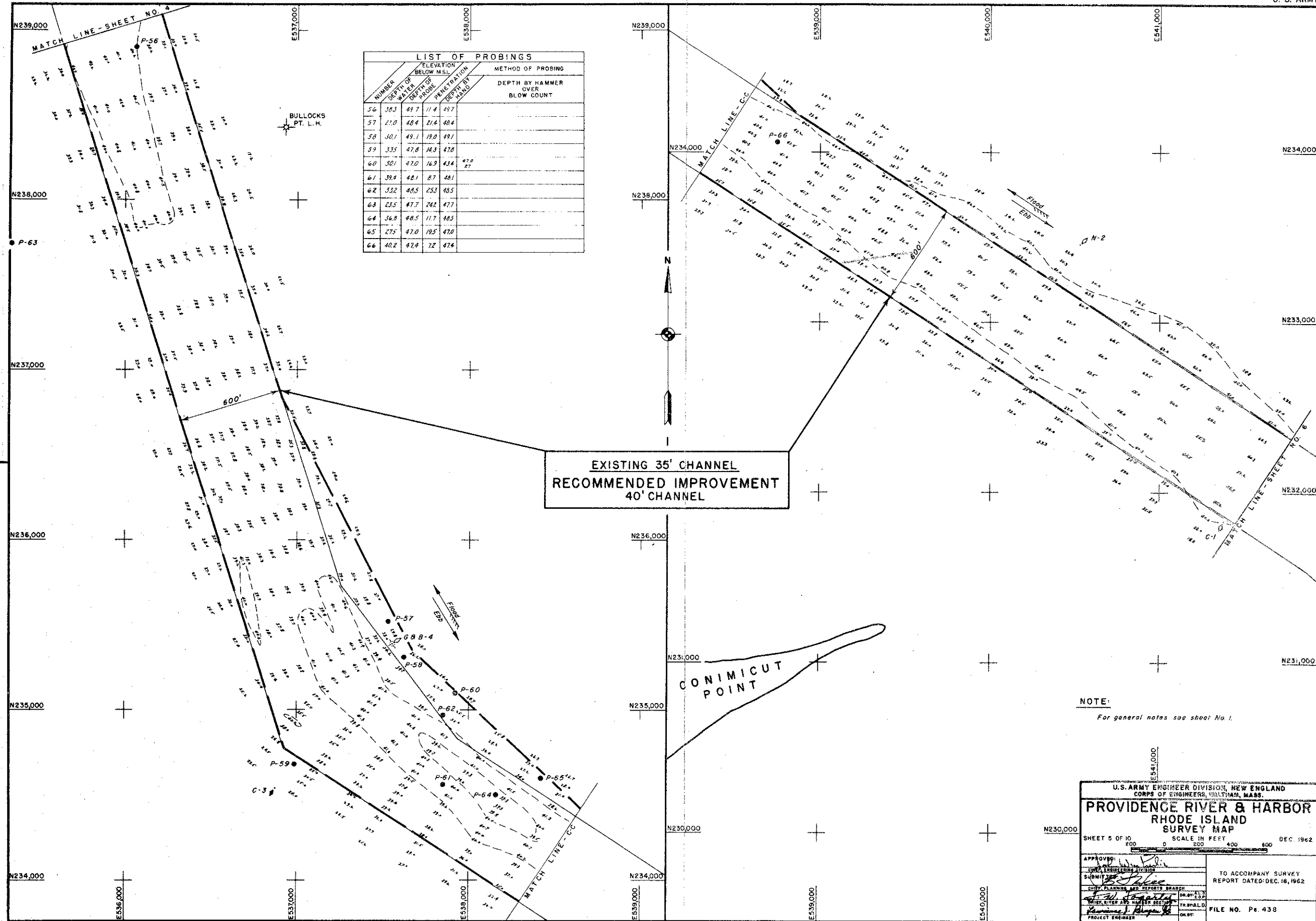


LIST OF PROBINGS					
NUMBER	ELEVATION BELOW M.S.L.		METHOD OF PROBING		DEPTH BY HAMMER OVER BLOW COUNT
	DEPTH OF WATER	DEPTH OF PROBE	PENETRATION	DEPTH BY HAND	
4	55.5	47.0	11.7	736	41.8 44.8 47.0 49.7 739 753
5	56.3	47.0	10.7	460	42.0 45.0
6	55.9	47.7	11.8	477	
7	50.0	48.9	10.9	489	
8	56.2	47.7	11.5	477	
9	56.9	47.4	10.5	474	









LIST OF PROBINGS					METHOD OF PROBING
NUMBER	DEPTH OF WATER	ELEVATION BELOW M.S.L.		DEPTH BY HAMMER OVER BLOW COUNT	
		DEPTH OF PROBE	PENETRATION DEPTH BY HAND		
56	38.3	49.7	11.4	49.7	
57	27.0	48.4	21.4	48.4	
58	30.1	49.1	19.0	49.1	
59	33.5	47.8	14.3	47.8	
60	50.1	47.0	16.9	43.4	47.0 27
61	39.4	48.1	8.7	48.1	
62	53.2	48.5	25.3	48.5	
63	23.5	47.7	24.2	47.7	
64	54.8	48.5	11.7	48.5	
65	27.5	47.0	19.5	47.0	
66	40.2	47.4	7.2	47.4	

